ELECTRICAL REVIEW

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2 APRIL 1954

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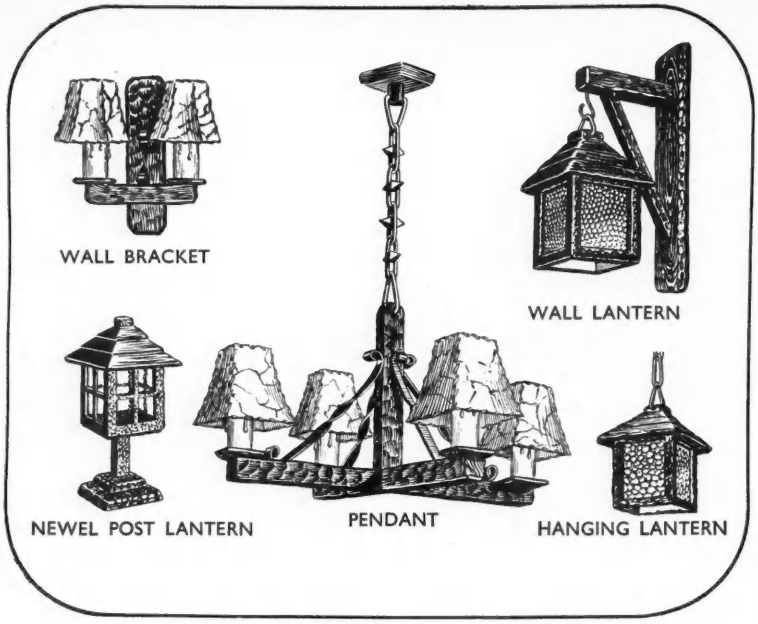
VOLUME 154 ✧ NUMBER 14

Eighty-Second Year of Publication

FRIDAY ✧ ONE SHILLING

Editorial, Advertising and Publishing Offices: Dorset House, Stamford Street, London, S.E.1. Telegraphic Address: "Elecrev, Sedist, London." Code: ABC. Telephone No. Waterloo 3333 (60 lines). Entered as Second Class Matter at the New York, U.S.A., Post Office. Annual Subscription: Home and Overseas £3 6s 0d: U.S.A. and Canada $11.00. Cheques & P.O.s (on Chief Office, London) payable to ELECTRICAL REVIEW PUBLICATIONS LTD., and crossed "Lloyds Bank."



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ELECTRICAL REVIEW

2 April 1954 Vol. 154 No. 14 Established 1872

Transistor Potentialities

WHEN the transistor was first introduced about six years ago many engineers thought that it was likely to revolutionize communications and electronic engineering techniques. Performing a similar function to a triode valve, it is very small, requires no heater power, is robust, comparatively simple to make, and is composed of materials likely to have an indefinite life. However, the reproducibility, reliability and power handling capacity of the device were initially far from the ideal and, furthermore, the problems of circuit design involved in incorporating it into equipment were very difficult. Another serious limitation of transistors is their inability to operate at high ambient temperatures.

Although continuous development work has, to some extent, mitigated these difficulties, the present state of knowledge on the subject, which is reviewed in an article elsewhere in this issue, indicates that without a doubt, transistors will not oust thermionic valves but will find individual fields of application for which they are inherently suitable. In spite of the functional similarity between thermionic valves and transistors it is a mistake to think that valves can be pulled out from equipment and transistors inserted in their place after making slight circuit modifications. In any case this practice would tend to restrict what could be done with the transistor and might make it appear as rather a poor substitute.

The thing to do is to take the transistor for what it is and build a new type of circuit technique around it. For instance, transistors work very well in pulse and switching circuits and it is highly probable that existing linear circuits could be adapted to this type of operation somewhat in the same way as a.c. techniques are used for amplifying d.c. fluctuations after having made the d.c. discontinuous. A particularly good example of this new circuit technique is in the new transistor operated computor which has recently been built at Manchester University. The outcome of the new approach is that there are fewer transistors in this computor than there would be valves in an equivalent thermionic valve operated equipment.

Another factor in favour of the transistor is the greater flexibility which is possible in the circuitry, and the development of complementarily symmetrical circuits with n–p–n and p–n–p junctions which have not been possible with thermionic valves. At the same time, however, it must be borne in mind that there is a limit on the operating frequency of transistors, due to the longer transit time of electrons and holes in semi-conducting materials.

There are two main types of transistor both of which have a price comparable with that of a sub-miniature thermionic valve; the point type, which was the first to be developed, and the more recent junction type. There is, perhaps, the feeling that the former is obsolescent, but this is not quite true since it is particularly suited to switching functions and at present it can be made to operate at higher frequencies more easily than the junction type. However, development work is proceeding to raise the operating frequency of the more robust junction types.

CROSS-CHANNEL POWER CABLE

Particulars given by Messrs. Sayers, Laborde and Lane in last night's I.E.E. paper (reported in this issue) concerning the preliminary sea trials of the proposed Franco-British high-voltage interconnector appear to establish its economic merits, provided the cable can be maintained in service with reasonable continuity. The authors' view as to the ability of manufacturers to supply an entirely reliable submarine power cable, particularly if, as seems probable with further development, it can be laid for the full underwater distance without joints is fully justified. External hazards, of a kind not met on land, are less certain factors and call for further progress in repair technique, which should be quite within the range of what is practicable. In any event the experience gained so far has been well worth while as an indication of our manufacturers' ability to tackle the most difficult under-sea schemes. A question that still awaits an answer is whether synchronism can be maintained between the two systems under all conditions of operation. If d.c. transmission, the development of which is held up largely because of the non-availability of suitable condenser equipment, were now practicable, it would solve this problem and others. It would, however, introduce problems of its own as the authors pointed out, such as the electrolytic corrosion of cable sheaths and magnetic effects on ships' compasses. Nevertheless the merits of d.c. transmission, especially for submarine cable, which can transmit two and a half times the power possible with a.c., are enough to warrant the suggestion made in the paper that a large scale experimental transmission deserves serious consideration.

SWITCHGEAR TESTING

Nearly 25 years ago A. Reyrolle & Co., Ltd., commissioned the first regular short-circuit testing station in Great Britain. This was extended in 1934 and its equivalent three-phase output (obtained in single-phase tests) was then about 1,100 MVA at the higher voltages, which included 132 kV. Later the demand for switchgear with higher rupturing capacities grew so rapidly that those testing facilities soon became inadequate and the limitations thus imposed tended to make it impossible to produce always the most economical design of switchgear. It thus became clear that a much larger testing plant was needed, while at the same time it was recognized that it would be most uneconomical to provide short-circuit loadings equal to the breaking capacity of certain large modern circuit breakers, e.g., 10,000 MVA at 275 kV, so that an alternative method of testing had to be sought. Fortunately, during latter years great strides have been made in developing the technique of unit testing and, as such tests can normally be made single-phase (which is generally suitable for large circuit breakers), a reasonable basis was provided on which to design the new plant. With the power available in the new station which was officially inaugurated last week by Lord Citrine, chairman, British Electricity Authority, and is described elsewhere in this issue, it is possible to make full-scale three-phase, single-phase or unit tests which will prove almost any gear likely to be built in the foreseeable future, and in this way a serious limitation has been removed from the designer and the door opened for the production of switchgear of the best possible type.

PRODUCTION AND EXPORTS

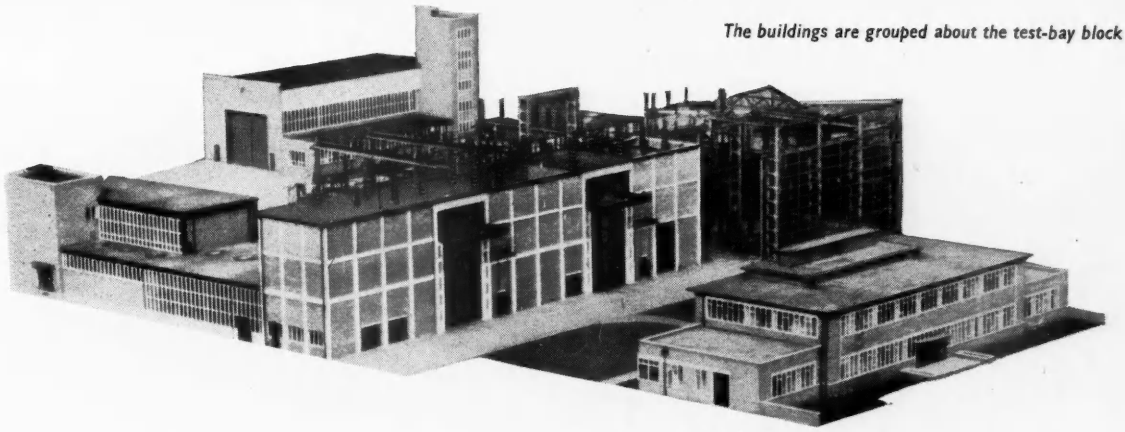
It is shown in the Index of Industrial Production prepared by the Central Statistical Office that the figure for the engineering, shipbuilding and electrical industries for 1953 was 129 (1948 = 100), slightly higher than the 1952 figure of 127; in the last quarter there was a rise to 138 (against 129). World exports of machinery and electrical apparatus in the first half of 1953 are put at £1,196 million (against £1,203 million in the first half of 1952) of which the United States was responsible for 38 per cent (37 per cent), the United Kingdom for 22 per cent (23 per cent), and Western Germany for 17 per cent (15 per cent). Thus while the American and British proportions of the slightly reduced total were lower, the share of Western Germany rose. We are constantly warned against "complacency," but it should be mentioned that German industry is still in the recovery stage and the advance is by no means spectacular. It is a fact, however, that Germany's re-emergence as a competitor and the probable need of the United States for greater overseas sales makes it imperative for British producers to keep their costs down and adapt their goods to their customers' ideas of design and price.

ENGINEERS AND REORGANIZATION

Both Lord Citrine, the chairman of the B.E.A., and Mr. A. R. Cooper, who has taken over the new Division, have given assurances that the staffs of the North Western and the Merseyside & North Wales Divisions, which are being amalgamated, will not be adversely effected by the reorganization. While accepting the assurances the Electrical Power Engineers' Association is perturbed at the way in which the amalgamation was planned and proceeded with. Its grievance is the secrecy which has surrounded the operations of the B.E.A.'s Organization Review Committee in the face of the need for consultation with the trade unions and the existence of joint consultation arrangements. Referring to "the restless atmosphere which has surrounded the nationalized industry in the last year or so," the *Electrical Power Engineer* appeals to the leaders of the Authority to end the uncertainty caused by the "unceasing talk of reorganization." After six years' experience, no doubt, the need for a revision of the original structure of the industry in some respects has become apparent. But if the employees constantly feel that something is about to happen to them it cannot do the industry any good and the B.E.A. should, if possible, be less secretive about its intentions.

ELECTRIC IRONS

The next in our series of domestic electrical equipment surveys, to be published on 9th April, will deal with electric irons



The buildings are grouped about the test-bay block

SWITCHGEAR RESEARCH

Reyrolle's New Station for Short-Circuit and Allied Testing

ON Tuesday last week Lord Citrine, chairman of the British Electricity Authority, officially inaugurated the new research station which has been established at Hebburn-on-Tyne by A. Reyrolle & Co., Ltd., for the short-circuit and allied testing of switchgear.

Although three-phase short circuits of very high loadings can be obtained up to 275 kV, the prime object of the station has been to provide the greatest possible single-phase loadings. These are achieved: (i) By taking advantage of the fact that in single-phase circuits with all the transformers connected in parallel, the lowest plant reactance can be obtained; (ii) by arranging the generators in so-called "U" connection, i.e., a single-phase arrangement using all windings in such a way that the reactance is reduced and the single-phase loading of each generator is increased by at least 33·3 per cent; (iii) by providing over-exciter sets which ensure a high recovery voltage, and correspondingly high currents during test, enabling the maximum benefits to be gained from the "U" connection; and (iv) by arranging to apply the short circuit at any selected point of the voltage wave, thus exercising complete control over the degree of asymmetry and making it possible for symmetrical tests to be made immediately after the start of the short circuit and before the sub-transient component of the current has died away.

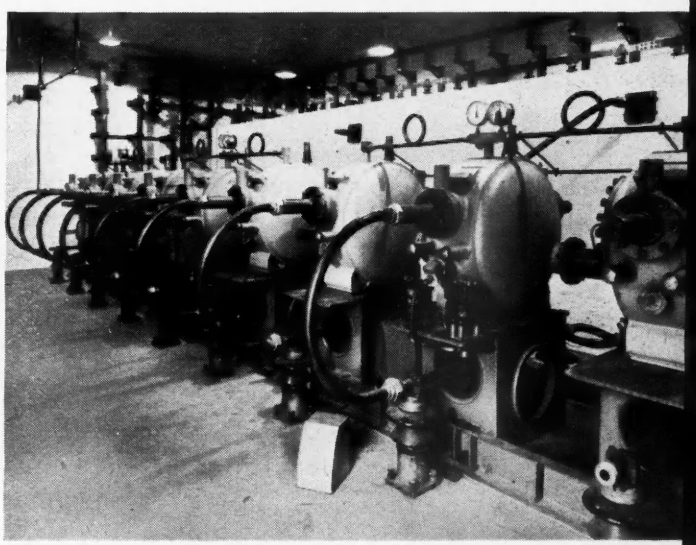
Source of Power

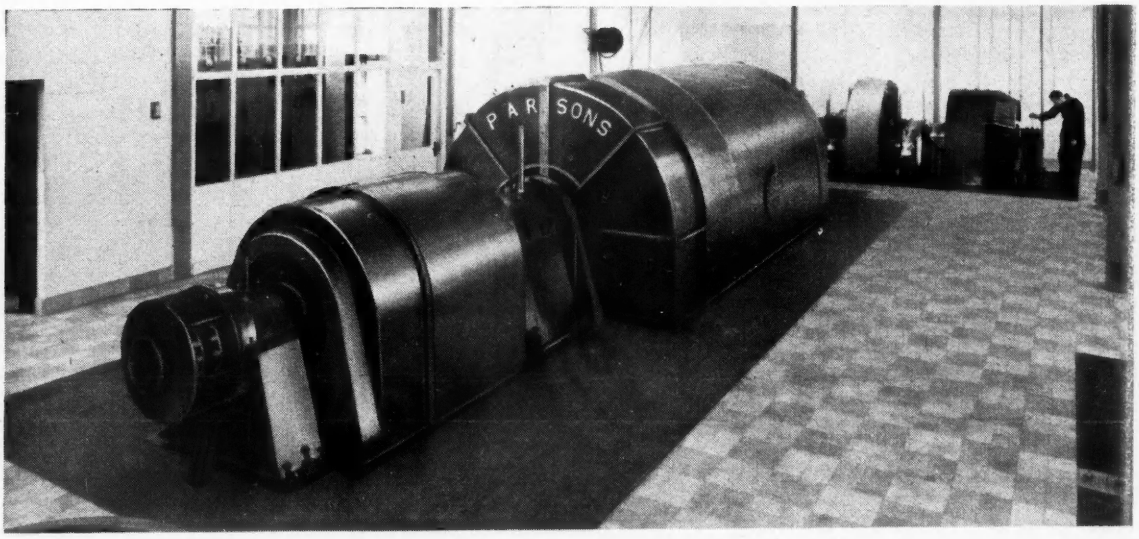
Three short-circuit generators, together with their associated over-exciter sets, provide the source of power. Each generator has its own master circuit breaker, current limiting reactors, resistors and making switch, and normally feeds its own group of e.h.v. transformers. The short-circuit generators are normally paralleled on the e.h.v. side of the transformers to avoid the very large currents which might otherwise flow in the event of a generator fault. This necessitates the provision of an auxiliary synchronizing tie to hold the machines in parallel before the application of the short-circuit loading. For this purpose two single-phase 500 kVA transformers are used.

Besides feeding the e.h.v. transformers, arrangements have been made to supply the test bays with power at generator voltages, or through a step-down transformer. The latter is intended mainly for short-time current-carrying tests where it may be necessary to maintain a heavy current for periods of up to five seconds. It can also be used for testing medium voltage switchgear, although most of this work will continue to be done in the 1929 station, which is being kept in commission as a generating station and for testing at all voltages up to 22 kV.

The plant is housed in a series of steel-framed brick and concrete buildings which are so arranged as to keep the conductor runs as simple as possible, to give clear access to all parts, and with an eye on the possibility of future developments. The buildings are grouped about the test-bay block which also houses the making switch from which the main connections radiate to all parts. The control building is situated about 100ft to the front of the test-bay block,

The three 3-phase "making" switches





The largest generator has a 60 MVA frame size

while the heavy plant is installed immediately behind it. Road and rail access is obtainable to all test areas and these link up with the erection shop nearby. The rail sidings have also been so arranged that they may be used for the handling of any of the heavy items of plant, should the need arise. The natural fall of the ground has been used to improve observation of the tests and to provide a measure of protection between the test bays and the safe areas.

The maximum loading of the station naturally occurs with full excitation or over-excitation, which means that it will be obtained at certain fixed voltages. These include the voltages in use in Great Britain and also some voltages used abroad. In each range the output is substantially the same at all these voltages. The position is summarized in the following table.

Voltage Range	System	Loading
Up to 22 kV	Three-phase	2,000 MVA
33 kV to 275 kV	Three-phase	1,500/2,500 MVA
66 kV to 380 kV	Single-phase	3,200 MVA* (with $\frac{1{\cdot}5E \text{ Recovery}}{\sqrt{3} \text{ Voltage}}$) 4,800 MVA* (with $\frac{E \text{ Recovery}}{\sqrt{3} \text{ Voltage}}$)

* Equivalent three-phase output

In order to avoid imposing repeated sudden loads on the supply system, the driving motors of the main generators are disconnected before the short circuits are applied. It is thus necessary to reconnect the generators and bring them up to speed again before each test. This is easily done from the control room by inserting small resistances in the slip-ring circuits of the motors before connecting the supply. These resistances are finally short circuited when the sets are nearly up to speed.

Synchronizing of the three sets is first effected with low excitation. Enough power can be generated in this way to hold the machines in step on no load, and when the excitation is raised under hand control care is taken to ensure that the generated voltage of each machine is the same.

For the tests at highest loading over-excitation is needed, and for this a timed sequence is introduced. After normal excitation has been adjusted by hand on open circuit, the over-excitation process is initiated with a number of definite time-lag relays operating in conjunction with the test-sequence controller. The over-excitation takes place in two stages: first the exciter field and then the main field are boosted. At a predetermined instant, calculated from the known excitation characteristics of the machine, the short-circuit test is applied.

The No. 3 generator is the largest in capacity and it has the following salient features: Frame size, 60 MVA; stator weight, 74 tons; rotor weight, 23 tons; speed, 3,000 r.p.m.; induction driving motor, 1,200 h.p.; and reactance, 4 per cent. The other two machines are similar in size and appearance, but their windings are arranged differently and their output is slightly lower.

All three generators are arranged with two windings per phase, which can be connected in series or parallel, star or delta, to give the four basic three-phase voltages of 6·35, 11, 12·7 and 22 kV. Intermediate voltages are arranged by excitation control. The " U " connection is also available to give 19·1 kV with normal excitation and 22 kV with over-excitation. The over-exciter set for No. 3 generator is also driven by an induction motor, and its characteristics are: Loading, 1,600 A at 625 V (or up to 3,000 A on short circuit of the alternator); speed, 750 r.p.m. A 12·5 ton flywheel is provided to improve the characteristics during short circuit. The over-exciter sets for Nos. 1 and 2 generators are similar, but are mounted on a common driving shaft.

The company's standard Class C switchgear with a rating of 150 MVA at 5·5 kV controls the main feed to the plant and the supplies to the 5·5 kV induction motors. D.c. switchgear for controlling the field currents has been specially designed for this duty, and the larger units may have to break currents of up to 3,000 A at about 1·5 kV, with an appreciable 100 c/s current superimposed. The master circuit breakers are a development of the standard Reyrolle Class R switchgear, and are fully phase separated. They can break the full loadings of the generators at any voltage, and this involves loadings of 50 kA at 22 kV, and 80 kA at 11 kV.

Current is controlled by reactors and resistors, the latter being used mainly to adjust the power factor. The reactors

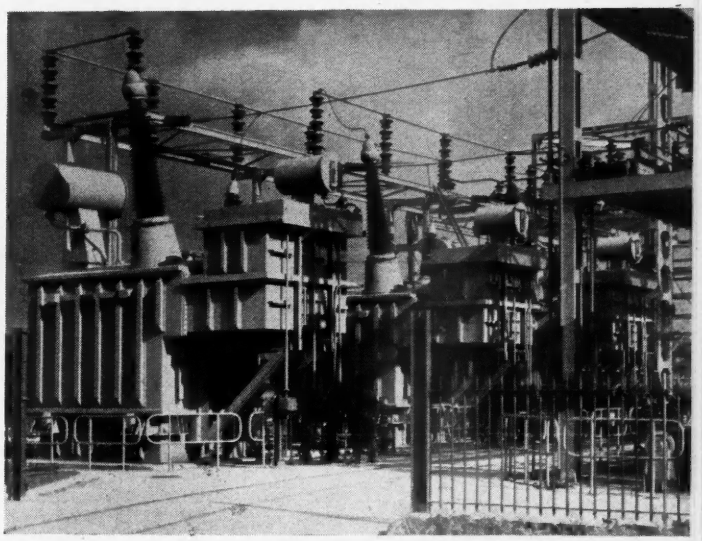
are arranged in two groups. Those for controlling the short-circuit current consist of air-cored coils in stacks of three. They are provided with tapping points, and self-locking isolator links permit rapid circuit changing. The reactors for controlling currents in the load-current range are three-phase iron-cored units which give a range of 5 to 250 A at 11 kV.

Arrangements in Test Bays

Normally, short circuits are applied through the three making-switch units (one for each generator). These switches close at any selected point of the voltage wave, and they have therefore been designed to precision limits. To reduce arcing before " make " the contacts are enclosed in compressed air at 150 lb/sq in and the speed of " make " is high. Operation is effected by pneumatically charged springs. All nine poles can be ganged mechanically with clutches between groups of three. They are capable of " making " with currents of up to over 150 kA peak. Control is exercised through a thyratron triggered from a 440 V supply in synchronism with the main sets and tied in with the main test sequence through the master controller.

There are two indoor and one outdoor test bays. The indoor bays are large enough to take a three-phase, 132 kV circuit breaker, while the outdoor bay can take a three-phase 380 kV circuit breaker. Each bay is provided with low voltage auxiliaries, measuring cables, an overhead crane, compressed air, switch oil and fire fighting facilities. The indoor bays have rear access through reinforced steel swing doors and, if necessary, these bays can be completely shut off by means of motor operated roller shutter doors at the front. Main circuit connections are brought to these bays at all voltages. The outdoor bay is provided with supplies at all voltages from 33 kV upwards, as well as with an l.v. and a medium voltage supply.

The main connections from each generator to the making switch consist of two 0·5 sq in three-core cables in parallel per unit. Similar cables connect the making-switch room to the e.h.v. transformers, and these cables run the length of the test-bay block in a subway which also carries oil, water, and compressed-air supplies, and cables for control and measurement. A connection room at the side of each test bay houses the short-circuit point. Current measuring



E.h.v. transformer bank

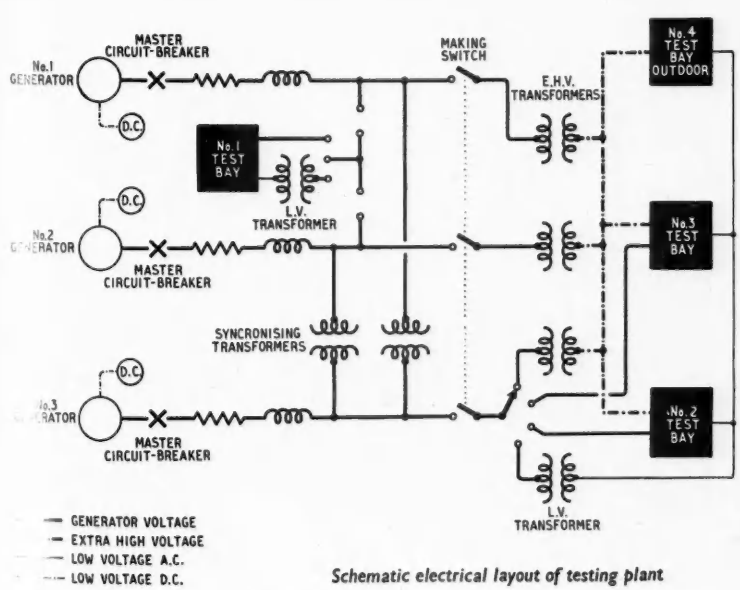
equipment and the like are also installed here, while one of these rooms also houses the two synchronizing transformers.

The e.h.v. transformer bank comprises twelve single-phase shell type 11/38 kV transformers, and three single-phase shell type 11/152 kV transformers. The reactances are as follows: 152 kV transformers, 3 per cent on a 50 MVA frame size; 38 kV transformers, 3·3 per cent on a 12·5 MVA frame size. The 152 kV transformers are provided with two primary windings, for 22 or 11 kV, and four secondary windings, each 38 kV, which can be connected in four series-parallel arrangements to give 38, 76, 114, and 152 kV. This method of connection keeps the transformer loading almost constant, irrespective of the voltage. The different arrangements are selected by oil-immersed switches.

On the primary side of all transformers the connections are open, and circuit changes are made through self-locking isolator links, similar to, though larger than, those used with the reactors. E.h.v. connections are switched by standard rotary isolators.

The auxiliary equipment provided includes d.c. generator sets and batteries for tripping and closing purposes, compressors for the operating of pneumatic gear and condensers for the control of RRRV (rate of rise in restriking voltage). The compressors are oil cooled and operate up to 1,000 lb/sq in, the air being cooled to take off surplus moisture and then expanded to about 600 lb/sq in at which pressure it is available for use as dry air.

Equipment is prepared for test in an erection bay situated a short distance from the test bays, where workshop and crane facilities are available, together with the means for making preliminary tests on the equipment before it goes to the test bay. A " Giraffe " tower ladder is available to give access to high gear. Smaller equipments are normally erected on



Schematic electrical layout of testing plant

flat-topped switched trucks which can be wheeled into the bay and rapidly connected up, while larger switches can be prepared only partly in the erection bay and finally assembled in the test bay. The erection bay also houses many of the domestic services such as central heating plant and oil handling plant.

Control is exercised from a central building, which also accommodates recording equipment, observation rooms, offices, and the like. One of the observation rooms is also available as a lecture theatre. The main control boards are arranged along the back wall, while the electromagnetic and cathode-ray oscillographs and the test sequence timer are in front of the control room. The cathode-ray oscillograph comprises four 10 kV sealed tubes, and records are obtained photographically on a rotating drum. The test sequence controller was designed to exercise individual control over the three generators and their exciters and for co-ordination of the test sequence. It consists of four radial arms, impelled by a spring and rotating in a horizontal plane to operate lightly set contacts mounted on a graduated circular scale. Up to 36 contacts may be operated in this way and a wide range of speeds is available.

The test control engineer operates from a position with a commanding view of the test bay and the nearby areas and has a simplified panel which indicates the plant in use and the position of the earthing switches. Before the test, circuits are checked on a supervisory panel which ensures that individual items of plant are not overloaded and that the circuit will produce the required current.

Extensive facilities are provided to deal with the many photographic techniques in use. The more important of these cover: Low-speed records from the electromagnetic oscillograph; high-speed records from the cathode-ray oscillograph; normal-speed cine records of the gear during test; high-speed cine records especially of individual components during test; still photographs of the condition of the gear at the various stages of test; and many types of reproduction.

The station is well equipped with photographic studios and dark rooms which permit all these various processes to be handled with the utmost dispatch.

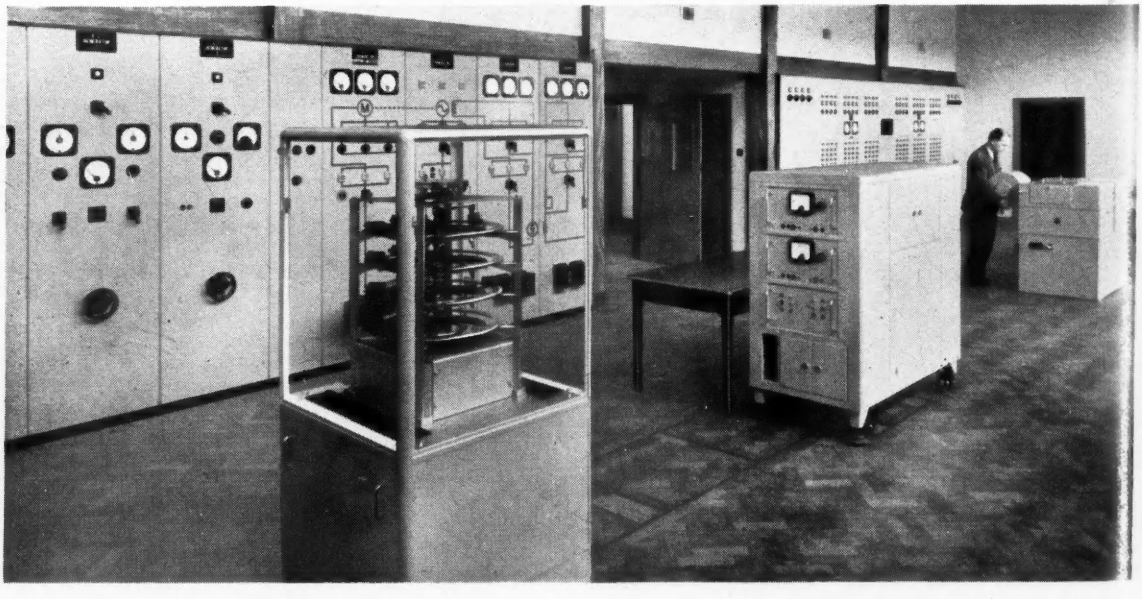
The last stage in a test series is the report of performance (issued under the auspices of A.S.T.A.) containing a complete record of the performance, together with photographs, drawings and oscillograms. When switchgear has been successfully proved an A.S.T.A. certificate based on the report of performance is normally issued.

The following are principals and firms who have played leading parts in establishing the station and supplying the equipment:—Architects, Messrs. Cackett, Burns Dick & MacKellar; consultants, Messrs. Merz & McLellan; main contractors, Alex. Anderson (Contractors), Ltd.; heating, G. N. Haden & Sons, Ltd.; lighting and wiring, Fairbairn & Partners, Ltd.; generators, power transformers and reactors, C. A. Parsons & Co., Ltd.; switchgear, controls, m.g. sets, copperwork and cathode-ray oscillograph, A. Reyrolle & Co., Ltd.; cables and condensers, British Insulated Callender's Cables, Ltd.; d.c. switchgear, Bertram Thomas (Engineers), Ltd.; starters, Allen West & Co., Ltd.; electromagnetic oscillographs, Cambridge Instrument Co., Ltd.; capacity dividers, Dubilier Condenser Co., Ltd.; batteries, Nife Batteries; pressure test transformer, Foster Transformers & Switchgear, Ltd.; fire fighting, Walter Kidde & Co., Ltd.; compressors, Hamworthy Engineering Co., Ltd.; cranes, John Smith (Keighley), Ltd.; " Giraffe " tower ladder, Wm. Moss & Sons, Ltd.; and telephone system, Siemens Bros. & Co., Ltd.

At the opening ceremony Sir Claude D. Gibb, chairman, A. Reyrolle & Co., Ltd., said that the new testing station had the greatest capacity of any such station in the world, and was about 50 per cent larger than the biggest station in the U.S.A. Sir Claude said that Reyrolles had decided that they could demand accuracy and efficiency from their production industry only if the latest machine tools and equipment were provided. It was also felt that engineers and designers should have adequate research tools.

Lord Citrine, who also unveiled a plaque to mark the occasion, said that electricity was an essential commodity, but they also looked forward to the development of atomic energy which would become an essential auxiliary to electric power. He stated that to meet the electricity demand by 1960 it would be necessary to install three times as much electrical plant as was installed in the record year before nationalization.

Control is exercised from a central building with a room commanding a view of the test bay



Franco-British Power Link

Joint Committee's Investigations

PROGRESS in investigations made up to the end of 1953 into the possibilities of a cross-Channel power link between the British and French electricity supply systems formed the subject of a paper presented yesterday before the Institution of Electrical Engineers, Supply Section, by Messrs. D. P. Sayers (Midlands Electricity Board, formerly B.E.A.), M. E. Laborde (Electricité de France) and F. J. Lane (B.E.A.). After a reference to the fate of Channel-tunnel schemes during the past century, the authors stated that the joint committee set up by the B.E.A. and Electricité de France had decided to confine their studies to the direct laying of cables on the sea bed. Most existing submarine power installations were comparatively short or operated at less than 60 kV, the longest in Great Britain being the 33 kV three-core cables to the Isle of Wight ($2\frac{3}{4}$ miles).

On the B.E.A. system 99 per cent of the 58,000 million kWh generated in 1952–53 was produced in thermal stations, whereas in France, in a year of average rainfall, 62 per cent of the 40,760 million kWh (in 1952) came from hydro-electric stations. Variation of summer and winter demands was much smaller in France and the annual load factor in 1952 was over 60 per cent as against 45 per cent here.

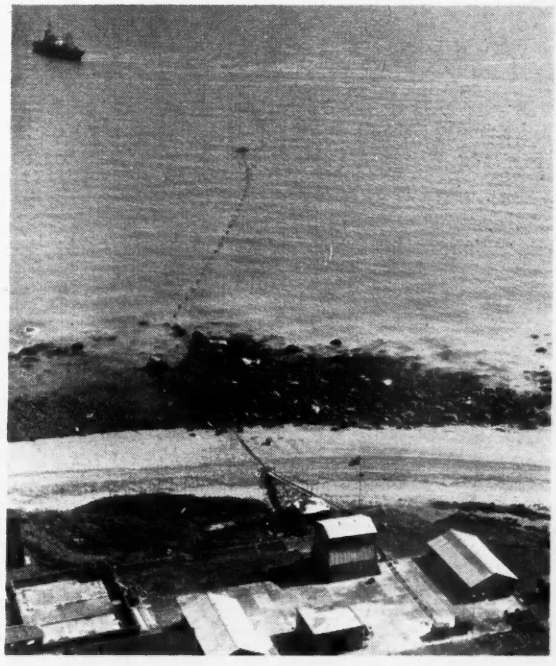
Interconnection Capacity

The British 132 kV grid point nearest to the proposed Dover–Calais crossing was at Folkestone, whereas on the 275 kV system it was at Northfleet 60 miles away. For the French 225 kV network it would be at Holque, 19 miles from Calais, the latter town being connected to a 90 kV system. A preliminary conclusion was that the initial capacity of interconnection should be not more than 400 MVA at 275 kV and not less than 100 MVA at 132 kV.

In view of the desirability of a relatively low charging current for minimizing voltage rise effects and of the greater capital cost (particularly for land connections) and the more complex technical problems involved in submarine work at 275 kV (a d.c. scheme not being immediately practicable), the committee confined its attention to a 132 kV scheme. For the lower voltage shunt reactors were considered unnecessary for limiting the effects of charging current but not at 275 kV.

Difficulties to be provided for in the 24 miles from coast to coast included the chemically active nature of the salt water, a tidal rise and fall up to about 20ft in a maximum depth of 216ft with tidal streams reaching 3·6 knots, rocks, sand banks (one rising to 15ft below the surface at low water), wrecks and dragging anchors. Also existing communication cables would have to be crossed by the power cables. Maximum water pressure was 96 lb/sq in and average water temperatures were 62 deg F in summer and 44 deg F in winter.

Three types of cables were considered and two were finally selected for trials. One was the gas-filled pre-impregnated design, which was used for the British trials. In this design



Cable testing site at Dover showing the cable being drawn ashore over ramps

the paper dielectric was impregnated before application, ensuring almost complete absence of free compound, and gas was maintained at 200 lb/sq in in the interstices of the insulation from pressure vessels at the terminals. Since the cable did not pass through impregnation tanks it could be made in much greater lengths than the others. Special arrangements would be necessary, however, for continuous lead sheathing and special production testing. Solution of these problems would enable the complete length of the cable to be made without joints. This cable had a low charging current.

The second cable was of the gas-compression type and was chosen for the French sea trials. In this the conductor, paper insulation and inner lead sheath (diaphragm) were oval and enclosed in a second, circular, lead sheath with gas under pressure between the two sheaths. The need for the cable to pass through impregnation tanks limited its length. An offset to the greater weight and cost of this type was the possibility of increased working stress. Single-core cables were preferred in both designs because of their smaller dimensions and simpler joints. They

TABLE I
APPROXIMATE COMPARISON OF 100- AND 400-MVA INTERCONNECTION SCHEMES
(Based on British Data)

Interconnection capacity	100 MVA	400 MVA
Voltage	132 kV	275 kV
Length of cable	26 miles	26 miles
Cable Particulars		
Type	Single core	Single core
Conductor size	0·2in²	0·6in²
Overall diameter	3·25in	5·25in
Unit weight	25 lb/yd	70 lb/yd
Total weight per cable	500 tons	1,400 tons
Losses at full load per 3-phase circuit	7,250 kW	7,500 kW
Charging current per phase	180 amp	316 amp
Charging power per 3-phase circuit	41 MVA	150 MVA
Estimated Costs		
Cost of four single-core cables and terminations	£2,900,000	£5,500,000
Cost of land connections		
England	£650,000	£1,400,000
France	£750,000	£4,600,000
Total cost of schemes	£4,300,000	£11,500,000
Total cost per kilowatt of capacity	£43	£29

would need to be laid 1,000 yd apart to provide adequate clearance for grappling.

For a load of 100 MW a conductor of 0·2 sq in would have been adequate, but to provide margins of mechanical strength in view of severe handling risks and of electrical flexibility in load transfers the area of the British cable was increased to 0·5 sq in. Radial thickness of the paper insulation was 0·5 in on the basis of a maximum stress at the conductor of 90 kV/cm and a screen stress of 41 kV/cm. The importance of the latter value was that the insulation under the copper-tape dielectric screen would be subjected to the most severe mechanical handling of the whole dielectric and to local heating associated with the sheathing process. To ensure freedom from vibration troubles the sheath was made of alloy E (0·4 per cent tin and 0·2 per cent antimony), which had a fatigue limit of 0·42 tons/sq in compared with 0·18 tons for pure lead and was rather more flexible than alloy B (0·85 per cent antimony). The minimum wall thickness of the lead sheath was fixed at 0·14in to prevent collapse under an external pressure of about 100 lb/sq in if the cable were laid without internal pressure.

Aluminium alloy was used for the wire armour, since this would reduce sheath and armour losses to 61 per cent of the conductor loss, compared with 170 per cent with galvanized steel. Its advantages were held to outweigh an increased risk of electro-chemical corrosion between the aluminium alloy wires and the bronze reinforcing tapes, if the interposed rubber layer were damaged, and abrasion effects six times those of steel when immersed in salt water.

A flexible joint was produced having the same external diameter as the main cable by butt-brazing individual strands and by lead-burning the outer lead sleeve of the joint to that of the main cable. This joint gave an impulse-withstand level of 550 kV compared with the normal 640 kV for the 132 kV grid, but the reduction was held to be satisfactory having regard to the modifying effect of the cable on surges entering from the system.

Sea Tests

The primary object of the sea trial between 21st July and 9th September last (*Electrical Review*, 7th August, 1953) was to determine the effect on the cable and joints of the severe mechanical conditions while being laid from the Post Office cable ship *Alert* (1,460 tons gross) and to obtain experience in making and laying joints at sea. The tests carried out with two 880ft lengths of British cable, each with a factory-made flexible joint, and one 230ft French impregnated cable, without flexible joint but with a stop-end joint, were modified owing to bad weather. In the initial fine weather one British cable was connected by a rigid joint to the French cable without serious difficulty and later in good weather was jointed to the second length in 34 hours. The joint between the British and French cables was completed in 26 hours. Gas pressure was then applied to the cables, which were tested by d.c. at 300 to

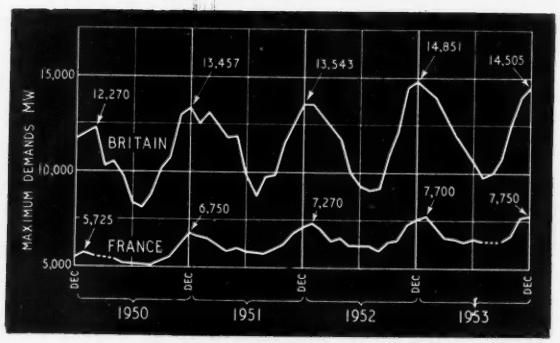


Fig. 1.—Variation in monthly demands between Great Britain and France, 1950–53

400 kV. The cables suffered damage in four places and subsequent examination at the works indicated the nature of requisite improvements. A jointing time of eight hours seemed possible with radical changes from conventional designs. The authors then gave particulars of the later French development programme at the Fontenay testing station, figures relating to which were shown in the table here reproduced.

In Britain a frequency change of 0·1 c/s corresponded to over- or under-generation of 300 MW and in France of 100 MW. The E. de F. system was already provided with a measure of automatic frequency control which was being extended. During the winter daily diversity of demand occurred mainly because French time was one hour in advance of G.M.T. In December (the most critical month in Britain) the French daily maximum demand occurred at 8.30 a.m. (7.30 G.M.T.), as against 5 p.m. (G.M.T.) here. Weather conditions differed, while the biggest demand risk was on Wednesdays in France and on Mondays in Britain. In 1952–53 the French m.d. was made on 9th January and the British on 15th December.

Recent experience had shown that a maximum winter diversity of 300 MW could be relied on. The combined capital saving through reduction in generating capacity was estimated at about £10 million to set against £4·3 million spent on a 100 MW interconnection yielding a net saving of £5·7 million. For a 400 MW scheme the saving would be only £3·5 million assuming a 300 MW diversity.

Energy Transfer

Three types of energy transfer had been investigated. The first was the export by France of hydro-electric spill energy otherwise wasted. The second was the exchange of surplus output of French hydro-electric stations for the output of British thermal stations with the highest fuel costs at the respective peak periods; this would also conserve French water storage, and the saving was estimated at £150,000. In the third case, when the cable would not

TABLE 2

PRINCIPAL CHARACTERISTICS OF 132 KV CABLES FOR THE BRITISH SEA TRIAL AND THE FRENCH TESTS AT THE WORKS AND AT FONTENAY

Cable	Rating	Conductor area	Maximum stress	Thickness of insulation	Armouring	Overall diameter	Weight	Losses per 26-mile 3-phase circuit at 100 MW				Charging current per phase
								Conductor	Dielectric	Sheath	Total	
British.	MVA	in²	kV/cm	in		in	lb/yd	kW	kW	kW	kW	amp
Pre-impregnated gas-filled ...	200	0·5	90	0·515	0·232in aluminium-alloy wires	3·6	36	1,410	141	860	2,411	208
French.												
Pre-impregnated gas-filled ...	200	0·62	85	0·54	0·2–	3·54	51	1,400	230	1,300	2,930	245
External compression ...	200	0·59	117·5	0·35	0·3-in	3·40	54	1,540	250	1,260	3,050	365
Pre-impregnated gas-filled ...	100	0·24	85	0·63	steel	3·30	42	4,370	140	3,240	7,750	155
External compression ...	100	0·19	125	0·40	wires	3·15	44	5,000	150	3,100	8,250	215

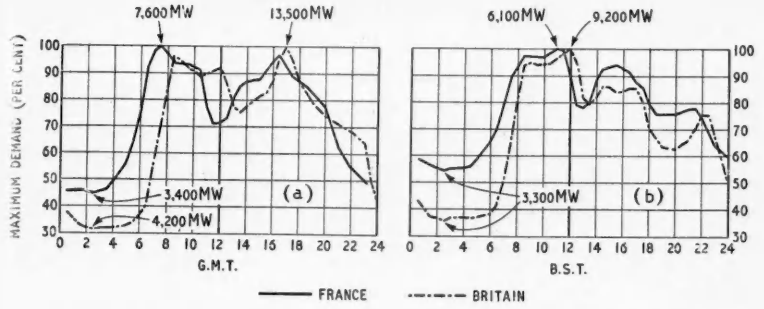


Fig. 2.—Daily load curves in relation to maximum demand; (a) for 10th December, 1952, (b) for 18th June, 1952

otherwise be fully utilized, economic exchanges could be made between thermal stations, based on a comparison of costs of production and transmission; the saving would be about £350,000 p.a. The total saving would in practice be rather less than the £600,000, which assumed ideal operation.

There was little doubt that suitable cables could be manufactured and installed; the only doubt that arose concerned the risk of breakdown after installation and the practicability of effecting quick repairs, though the provision of a fourth single-core cable as a spare would increase reliability. A second question was whether the two systems could operate continuously in parallel through an interconnector of the size under consideration. The prudent course appeared to be to install initially a link of the minimum capacity consistent with reliable operation but planned with a view to increasing the capacity when service experience had proved its worth.

Acknowledgment was made to those who, with the authors, had been directly associated with the meetings of the joint committee. They were: from Electricité de France, Messrs. P. Ailleret (chairman), P. Grezel, A. Antoine, G. Bardon, G. Nasse and R. Tellier; from the B.E.A., Messrs. E. R. Wilkinson (chairman), C. W. Marshall, W. B. Noddings, P. J. Squire, G. R. Peterson, J. S. Forrest and C. C. Barnes.

Mercury-Arc Rectifiers

In the discussion of the paper on cathode-spot behaviour and the thermal control of the emission zone in mercury-arc rectifiers, presented by Dr. H. von Bertele on 24th March at a meeting of the Supply Section of the Institution of Electrical Engineers and summarized in the *Electrical Review* of 26th March, Dr. W. G. Thompson (G.E.C.) referred to a common experience of rectifier manufacturers that the engineering job of producing a rectifier incorporating the suggestions of physicists had generally given disappointing results. It had therefore been necessary to produce a rectifier according to the best theoretical knowledge available, but to try it out on the test bed and obtain service experience from it, then to plough back that experience, guided by whatever theories were fashionable at the time.

Sir J. J. Thomson had pointed out that at the cathode spot there was an incoming stream of ions and that the vapour pressure conditions might be much higher than would be judged from the surrounding low-pressure conditions in the vessel itself. Thermionic emission was likely to play a much greater part in the production of electrons from the cathode spot than some later authorities had suggested. Dr. Thompson's own work had led him to the conclusion that where there was a concentration of energy in a very local area such as a cathode spot, then no matter how well one cooled the reverse face of the block of material on which the cathode spot remained, one could not prevent a very high temperature rise under the spot itself. The use of a high melting point material was not sufficient because the metal was not so much melted away as boiled away.

The users of rectifiers expected them to stand up to rough handling. There was not only the question of the specified overload but also that of sudden temperature changes, and even short circuits, while rectifiers had been known to backfire. In general the idea of rectifier design was to keep things as simple and straightforward as possible, but if the author could produce a small rectifying vessel which was comparable to some of the larger sizes of hot-cathode rectifier and bridge the gap between the hot-cathode rectifier and the mercury-pool rectifier, there were applications where precision of control was required where a design of that type might show up to advantage.

Dr. A. von Engel (Clarendon Laboratory, Oxford) described investigations into the reverse motion of the cathode spot of an arc, a motion opposite to the usual left-hand rule which caused the spot to move in what might be described as the wrong direction. The force which acted on the gaseous conductor appeared to be the sum of two components, one of which was proportional to the current and magnetic field applied, while the other and more interesting one was the loop force due to the current which flowed through a conductor, setting up its self-magnetic field, and had a tendency to move in such a direction that the loop was enlarged. This second force was therefore proportional to the square of the current, and accordingly did not depend upon the direction of the current. That was supported by the fact that if one took an arc which had the cathode spot at the surface of tantalum, and applied a magnetic field with sufficiently low pressure, it moved in the wrong direction, but if one allowed that tantalum to warm up and the spot to grow, the reverse motion stopped.

Mr. J. E. Calverley (E.E.C.) commented on the proposal to reduce the amount of mercury in the pool and possibly eliminate it altogether.

The author briefly replied, and Dr. L. G. Brazier, chairman of the Supply Section, said that as it became increasingly difficult to put power stations just where electricity was wanted thoughts had turned to d.c. transmission, and the stimulus to do so had been increased by recent developments in submarine power cables. Dr. Thompson had mentioned the backfiring of mercury-arc rectifiers and, whether for that or other reasons, the development of d.c. transmission seemed to be making slow progress.

New Refrigerators

Improved Models for Domestic Use

SEVERAL new domestic refrigerators have just been placed on the market. Besides incorporating a new feature, the "Butterdor" compartment for storing butter, in its "CT.45" 4½ cu ft and "CS.70" 7·1 cu ft models, the INTERNATIONAL REFRIGERATOR CO., LTD., Fletton, has introduced two new "Coldrator" table-top models, the "AT.18" 1½ cu ft absorption type unit and the "CT.33" 3·3 cu ft model incorporating a new design of hermetically sealed compressor with a wire mesh condenser.

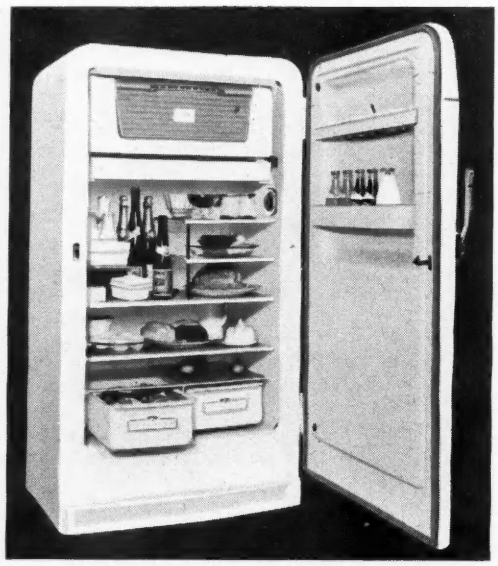
A vitreous enamelled table top, a blue p.v.c. inner liner, a chiller dish and an 18 cube aluminium ice tray are features of the "AT.18" machine which has a shelf area of 3 cu ft and sells at £38 (plus £13 12s purchase tax in the United Kingdom). The "CT.33," which is priced at £55 (plus £20 0s 6d P.T.), has a one-piece moulded table top, a nylon-hinged door, a stainless steel freezer with a 20 cube ice tray, and three shelves with an area totalling 6·1 sq ft. The prices of the "CT.45" and "CS.70" models are respectively £73 (plus £26 5s 2d P.T.) and £99 (plus £36 1s 8d).

In addition to its standard range of 4·25 cu ft, 7·3 cu ft and 9·1 cu ft models FRIGIDAIRE (DIVISION OF GENERAL MOTORS), LTD., Stag Lane, Kingsbury, London, N.W.9, has brought out two de luxe models with "across-the-top super-freezer chests." The "O.D.T.-77" 7·7 cu ft model has storage capacity for 45 lb of frozen foods or ice cream; the "O.D.T.-95" 9·5 cu ft model 51 lb. In addition to 13·1 sq ft and 18·1 sq ft respectively of storage area they have two door shelves. The "O.D.T.-77" costs £95 8s 1d (plus £36 0s 11d P.T.) and the "O.D.T.-95" £123 12s (plus £46 14s P.T.). New substantially reduced prices of the other models are "T.O.R.-42" 4·25 cu ft, £54 11s 7d plus £20 12s 5d P.T.), "O.O.R.-42" 4·25 cu ft (without table top), £53 16s 4d (plus £20 6s 8d P.T.), "O.M.T.-74" 7·4 cu ft, £83 19s 5d (plus £31 14s 7d) and "O.M.T.-92" 9·1 cu ft, £112 18s 7d (plus £43 13s 5d). In addition there is a first year service fee of £2 10s for the 4·25 cu ft models and £4 for the others.

New English Electric, G.E.C. and Electrolux models were illustrated and briefly described in the review of the Ideal Home Exhibition on pages 415–7 of our 5th March issue. Features incorporated in the English Electric "EA.83" 8·3 cu ft model are an across-the-top freezer, a low temperature "Coldrawer," an egg-rack and two shelves fitted to the inner door panel. Special plastic drawers provide ideal storage for fresh fruit and vegetables, and have ridged glass covers which make an extra shelf. A recessed interior light is provided. The price is £100 12s (plus £38 P.T.). Measuring only 22in square by 36in high, the "EA.34" model has a capacity of 3·4 cu ft and a shelf area of 6·4 sq ft. Models are available in either cream or white enamel with the door hinged either left or right. The freezer door and storage tray are of turquoise blue plastic. This model sells at £48 0s 3d (plus £18 2s 9d P.T.).

In the G.E.C.'s new 3 cu ft refrigerator the plastic-on-steel interior is hard, unchippable and resistant to all acids and alkalis found in foodstuffs or normal cleaning materials. Improvements in the sealed system ensure low current consumption. Other features are a full length door, a curved front without sharp corners, a shelf area of 6 sq ft and a stainless steel freezer holding packets of frozen foods or providing 1·4 lb of ice cubes per freeze. The price is £48 9s including £2 installation charge (plus £17 11s P.T.).

The new "L.500" 5 cu ft Electrolux model incorporates a bow front, an interior light, a large frozen storage and ice making compartment with translucent plastic doors and two door shelves. It has a shelf area of 9¾ sq ft and costs £81 10s (plus £30 15s 10d P.T.).



Frigidaire "O.D.T.-95"

Coldrator "AT.18"

Coldrator "CT.33"

BRADFORD EXHIBITION

An "Electricity in the Home" Exhibition organized by the Department of Electrical Engineering will be held at Bradford Technical College on 10th April from 11 a.m. to 8 p.m. Over forty manufacturers are participating. Admission is free.

Engineering in Europe

Abstracts from Foreign Technical Journals

SINGLE-PHASE traction at the commercial frequency has lately attracted the interest of the specialists, and theoretical and experimental researches on the subject have been carried out, apart from the more or less experimental lines of this type in the United States, Great Britain and some European countries. Since the French Railways consider the introduction of this type of traction on a larger scale, the engineers had to investigate the mutual influences of supply and traction systems, particularly the asymmetrical conditions of the supply system, their necessary limitations and compensation by stationary and rotating machinery. The most favourable solution of this problem seems to be the use of Leblanc or Scott-type transformers for the interconnection of supply and traction systems, if necessary, with a two-phase booster alternator supplying a tertiary winding of the Scott transformer.

The actual solution of the supply problem is, however, always a mixed economic and technical question and depends on various factors such as possible number of substations or interconnecting transformers, and spacing between the latter (which in many cases may be single-phase transformers). There are also cases in which general power supply and traction supply may be combined and carried out by three-phase transformers in special connections. The author shows and discusses the main types of possible solutions and indicates the particular conditions under which each of these circuits will be the preferred one.—" Supply of a 50 c/s Traction System by a Public Power System," G. Marty, *Rev. Alsthom*, No. 94, pp. 33–45, 1953, in French.

Synthetic Transformer Oils

The author compares the physical, chemical and electrical characteristics of pyralene (diphenyl $C_{12}H_{10}$) as a transformer coolant with those of natural oils. The greater specific gravity is a drawback more than compensated for by the fact that moisture penetrating into the coolant will remain on the surface and can easily be removed. The viscosity of pyralene is lower than that of oils, and the hygroscopicity averages only 3×10^{-5}. Although pyralene has a lower specific heat than oil, its thermal capacity is approximately the same as that of oil and is, moreover, hardly affected by temperature, a marked advantage for the heat exchange from the cooler parts of the transformer tank which is thereby accelerated.

Transformers with pyralene filling do not require conservators owing to the chemical stability of the liquid, which is not oxidized by, and thus need not be separated from, the ambient air. The acid value of pyralene is lower than 0·01. It does not attack metals but decomposes some insulating materials, which has to be considered in designing transformers for pyralene cooling. The dielectric constant of pyralene and its breakdown voltage are considerably higher than those of natural oils, but the dielectric loss factor is also slightly higher than that of oil.

A great advantage is that pyralene does not require any special maintenance or regeneration, except after breakdowns of transformers. The author analyses the dielectric stress distribution in pyralene-cooled and an oil-cooled transformers as a numerical example and illustration of the advantages of the former coolant.—" Cooling of Transformers by Synthetic Oils (Askarels)," J. Hapl, *Elektrotechn. Obz.*, Vol. 42, No. 11, pp. 632–635, 1953, in Czech.

Accelerated Ageing of Oils

Manufacturers of insulating oils quite generally use accelerated ageing tests based on chemical processes, but less attention is paid to the temporary and permanent deterioration of the oil characteristics by electric stresses. These deteriorations consist mainly in X-wax formation, gassing, polymerization of the oil and accumulation of polar molecules and microscopic inhomogeneities. Nearly all these effects are due to micro-gas-discharges occurring at points of electric stress concentration.

The accelerated-ageing apparatus works with a 400 c/s generator working on a 12 kV transformer, the frequency chosen resulting in sufficiently intense, yet uniform and weak discharges, so that an excessive temperature rise of the oil is avoided. The current density must not exceed certain limits. The principle applied was used as long ago as 1857 by Werner Siemens and consists of the insertion of insulating layers with a capacitive effect between electrodes and discharge space. This renders the discharge uniform and suppresses its thermal component. The electrodes of the discharge vessel consist of water kept at a temperature corresponding to the chosen operating temperature, say, 70 deg C. The discharge vessel is evacuated and the voltage applied is increased until the oil foams. The gases liberated are then drawn off and the ageing process proper is then initiated by a further increase of the voltage up to 12 kV. The test is carried on until the pressure has risen by 60 mm Hg. The consumption measured in mA/min is used as a characteristic of the resistance to ageing of the oil.—" An Electrical Apparatus for Accelerated Ageing of Insulating Oils," T. Rummel, *Siemens Z.*, Vol. 27, No. 8, pp. 431–3, 1953, in German.

Electrification of Mines

It is interesting to learn from the author that the percentage of electrified mines in Belgium is roughly double that in Germany, and still less than half of the percentage achieved in Great Britain and the United States. The explanation given is that on the Continent compressed air and electric power are still equally favoured for underground drives and the former even preferred in Germany, partly for economic reasons and because of the shortage of copper during the war. Also, the Continental designer's approach to heavy equipment such as circuit breakers, transformers and motors for underground operation must be more cautious than that of his colleagues overseas, probably because the dangers of fire damp explosions are more acute on the Continent owing to the special characteristics of the coal strata.

The upshot of this attitude is a series of interesting designs, particularly dry transformers, totally enclosed underground substations (stationary and mobile) and special types of circuit breakers, mainly developed by French and German firms. Even more elaborate are the many protective systems and devices for h.v. and l.v.

Readers who require accurate full translations of any of the articles abstracted in this section can be put into touch with the translators who will supply them at current rates.—Editors, *Electrical Review*.

systems in mines. The selective operation of these protections is, if anything, even more important below than above ground and for this reason the specialized industries have made great efforts to evolve foolproof designs.

The theory of such highly-selective protective systems is not a simple matter, but the supervising authorities in various countries have worked out detailed instructions in this respect which have to be followed by anybody applying for the commissioning of underground electrical plant.—" New Viewpoints on the Electrification of Underground Workings," L. Chenoy, *Bull. Ass. Ing. Elect. Montefiore*, No. 10, pp. 729–761, 1953, in French.

Radial-Cored Transformers and Reactors

Radial cores for transformers and reactors have been known now for about 50 years, since the Berry patents were granted at the beginning of the century, but despite their considerable merits they have never been used on a large scale. This was mainly due to difficulties in their production which have been overcome only comparatively recently by modern welding methods.

The great advantage of radial cores is mainly their small height and low iron losses, this being of particular value in the case of modern e.h.v. transformers (mostly single-phase units but sometimes three-phase) for high outputs and large reactors, where, in the first case, large cross-sections of the magnetic path and large insulating clearances are required together with large window areas (for high output); in the second case, the low iron losses enable reactors with considerable air gaps to be built for purposes of continuous regulation without changing the width of the gap. The low iron losses are due to the fact that the flux follows practically always the direction of the stampings and never runs normal to the stacks of sheets.

The author presents a method of calculating the main parameters of such cores for given ratings, concentrating particularly on the determination of the optimum space factor of the cross-section. These calculations are used for the design of the magnetic circuits of a single-phase transformer and a reactor, respectively, general principles and details of the actual production of such cores being given in the concluding section.—" Magnetic Circuit with Radial Laminated Core," J. Kopecek, *Elektrotechn. Obz.*, Vol. 42, No. 11, pp. 624–631, 1953, in Czech.

Reconditioning Power Cables

Operating experience is reported with various cables in which extreme temperature differences had led not only to displacement of the impregnating compound but also to the formation of cracks in the lead sheath during the period of the temperature rise. Various topping-up installations for the impregnation, partly with automatic operation, were tried out and certain types were found very satisfactory, when some less successful types had been eliminated. As a rule, these installations are mounted on the potheads of cables, the most important part of every installation being an expander vessel at the highest point of the section into which the expanding compound may rise at high ambient temperatures, to flow back when the temperature falls again.

The cable end itself is surrounded by asphalt cement which forms an elastic pressure seal inside the pothead. The designs for individual potheads and trifurcating boxes (for single-core and three-core cables) are somewhat different, particularly since in the latter case expander vessel and topping-up tank must be separated, but the principle of operation is the same. The topping-up tank must be provided with a breather, the end of which is turned downwards, so that no moisture can get into it. With the improved topping-up devices all the generator and transformer cables of the system worked satisfactorily and without breakdowns for several years.—" Drying-Out of Power Cables and Method of Reconditioning them " V. T. Kalita, *Elekt. St.*, Vol. 24, No. 9, pp. 41–3, 1953, in Russian.

High-Voltage Commutators

As a rule, the voltage per bar of small machines must not exceed 50 V and that of larger machines 20 to 30 V. In exceptional cases voltages up to 150 V per bar are possible in h.v. generators of low output. However, for some purposes even higher voltages per bar would be desirable for machines of high output. The problem is admittedly difficult and its solution was tried on an experimental h.v. generator, 100 kW, 3,000 r.p.m. by the use of novel commutator design.

The principles of this commutator design may be briefly described as elimination of solid insulation (mica) between the segments where they run under the brushes and cranking of the segments in this zone (for improving the running characteristics). Not only is the insulation of the segments improved thereby, but also the ventilation of the commutator and, most important, a scavenging of ionized air, carbon and metal dust is obtained, reducing the danger of flashovers. In one of the no-load tests a terminal voltage of 4,600 V (corresponding to 460 V per bar) was reached before a flashover causing serious damage occurred.

However, it was established that voltages per bar up to 200 V on-load may be safely attained with the novel commutator design, provided that surface and tracking discharges on the commutator are prevented by an additional varnish coat on the side faces of the segments, by reduction of the reactance voltage, and by improvement of the conditions of the commutation by choosing a more suitable type of winding than that used on the experimental machine (simple wave winding).—" Commutator for High Voltages per Bar," R. Bruderlink and H. G. Sauer, *E.T.Z. (B)*, Vol. 5, No. 10, pp. 327–330, 1953, in German.

High-Voltage Fuses

Test series for establishing the appropriate working ranges of expulsion and tubular fuses in indoor transformer stations were carried out in the 3, 5, 16 and 20 kV systems of the Austrian grid. The tests yielded that an expulsion fuse evolved by the company operating the grid could control all the voltage ranges considered up to 100 MVA power. Tubular fuses were found unsuitable for use in h.v. systems. Also, the primary and replacement costs of expulsion fuses are low. A particular advantage is that existing tubular fuse bases and carriers may be converted to expulsion fuses by insertion of a fibre tube, with the added advantage that the same type of expulsion fuse may be used up to 25 kV, thus a standardization of all h.v. fuses to a single size for medium-voltage systems is obtained. Replacement is thus simplified and its costs are reduced

However, certain silver fuse elements tested were found unsuitable for voltages above 15 kV and introduced dangers of destruction of fuse-holders and bases. A molybdenum-alloy fuse wire introduced instead of the silver wire answered very well at the high voltages, whereas the silver wire is more satisfactory for voltages up to 10 kV. Despite the high powers controllable, certain limitations for the indoor use of the expulsion fuses are imposed by their sizes and the violent reports and pressure rises produced when the fuses blow.—" New Experience on the Use of h.v. Fuses," S. Czajka, *O.Z.E.*, Vol. 7, No. 1, pp. 18–23, January, 1954, in German.

VIEWS on the NEWS

By REFLECTOR

LORD MONKSWELL, in an article contributed to the *Daily Telegraph* of 22nd March on "Speed on the Rails," says that "electricity has obvious advantages for underground railways but for little else." The little else and oh how much it is! He proceeds to damn railway electrification with arguments of doubtful validity. He says, for instance:—

> "Electric motors are far more expensive than steam locomotives in first cost, but there is the advantage that power station plants can use cheap, inferior fuel while their efficiency —the percentage of heat from the furnace converted into power —is about double that of the cylinders of a steam locomotive. But as the railways burn only about 6 per cent of the coal mined, electrification cannot produce any spectacular economy."

Power station efficiency is much more than double that of the average locomotive. As to economy, complete electrification would enable us to export annually from 10 to 15 million tons of good coal now wasted by steam locomotives.

Lord Monkswell suggests that "the whole subject of the finance of electrification is a jealously guarded secret." It may be under nationalization, but the beneficial effects used to be apparent in comparisons of the finances of the Southern Railway with those of the other groups.

The case against Lord Monkswell's ideas was ably put in a letter by Mr. G. Nabarro, M.P., in the *Daily Telegraph* of 25th March. In addition to the points I have made above he referred to the abatement of smoke nuisance and the improvement of the B.E.A.'s load factor which electrification would bring about.

* * *

Canon Roger Lloyd, an enthusiastic amateur authority on railways, recalled in an article in last week's *Spectator* how many times British railways had been in the doldrums to be rescued on each occasion by the emergence of a "great man." He particularly mentioned the names of Stephenson, Brunel, Hudson, Ellis and Sir Richard Moon. He went on to say:—

> "The tradition has survived into modern times. In living memory it was Sir Herbert Walker who put the Southern on its feet, and made it in many ways the richest of the four great groups. The tremendous scheme of suburban and main line electrification was his, as was the vision and the hard work which created the New Docks at Southampton. . . ."

Canon Lloyd considered that the railways still offered the best and safest form of suburban and long distance travel and the best means of freight haulage. He concluded his article by calling for "the Great Railwayman, who by his greatness will cut a path through this jungle [of administrative paper work] and carry the whole service with him." The author might have particularly commended Sir Herbert Walker and his electrification schemes as the most desirable type of "Great Railwayman" for modern times.

* * *

In one of my notes of 19th February I suggested that the time had come for a repetition of the campaign for adequate wiring which E.D.A. conducted some years ago. I am glad to have the backing of Mr. S. F. Steward, chairman of the South Western Electricity Board, in my call for better installations. Last week, Mr. Steward impressed upon members of the Bristol Branch of the Electrical Association for Women that plenty of power points, conveniently placed, were essential in the modern home. He said that too little attention had been paid to this in too many post-war houses and in thousands of older homes the wiring systems were out-of-date and inadequate to take full advantage of electricity. He also criticized the general standard of domestic lighting. I hope that electrical contractors will seize on these as good follow-up points in connection with the E.D.A. campaign now in progress.

* * *

Coinciding with E.D.A.'s all-out domestic electrification campaign are similar efforts promoted by the American Edison Electric Institute (which was formerly the National Electric Light Association with objects similar to those of E.D.A.). The E.E.I. is running two campaigns during the spring designed to raise the sales of electric cookers and water heaters and is employing the slogan "Be Modern—Live Electrically." It is expected that all branches of the industry—utility companies, manufacturers, distributors and dealers will develop their own approaches to the public in conjunction with material supplied by the Institute.

* * *

At a meeting last week of the Salmon and Trout Association the president, Lord Hollenden, spoke about electrical methods of controlling the movements of freshwater fish, a subject to which I have made frequent reference. He referred to a "disturbing" report which suggested that some of these methods were possibly injurious to the fish. It was said that the use of alternating current for the purpose of sorting the fish population of rivers had a slow, shattering effect on the vertebrae of a trout. The fish was not immediately killed; the vertebrae healed but were left stiff or immobile and as a consequence the trout subsequently died. Lord Hollenden spoke with approval of the experiments in the use of electricity to prevent fish from getting into the turbines of hydro-electric stations.

* * *

Reminders of the good old rate-relief days of electricity supply are constantly cropping up. Usually, of course, those who regret that they can no longer milk the electricity department funds as a means of securing revenue for general purposes are local authorities. It is rare to hear consumers complaining that they no longer (in effect) have to pay extra rates. And yet a writer in the *Morning Advertiser* (the organ of the licensed trade) says:—

> "Most licencees sigh for the days when they may have obtained their electricity from a municipal undertaking which not only charged them reasonable tariffs, but made profits which helped to keep down the rates."

I refuse to believe that a tariff which included a rate-relief element was reasonable.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

NEW Fellows elected to the Royal Society include **Sir Christopher Hinton,** managing director, Industrial Group, Department of Atomic Energy, and well known for the part he has played in the development of large production plants in the Atomic Energy Project, and **Mr. J. L. Pawsey,** assistant chief, Radiophysics Division, Commonwealth Scientific and Industrial Research Organization, Sydney, who is distinguished for his contributions to techniques of radio and radar, and in particular for his applications of these techniques to radio astronomy and to the study of the ionosphere.

The following additions have been made to the board of Brookhirst Switchgear, Ltd.:—**Mr. F. A. Leonard** (sales director), **Mr. R. Pagett** (works director), **Mr. W. Davies** (director and chief engineer) and **Mr. R. Wallace** (commercial director).

Several new appointments are announced by Henry Wiggin & Co., Ltd., with effect from 1st May. **Mr. J. O. Hitchcock** will relinquish his position as assistant managing director of the Wiggin Co. to assume the position of assistant to the chairman of the Mond Nickel Co., Ltd. He remains a member of the Wiggin board. **Mr. H. W. G. Hignett,** superintendent of the Mond Nickel Co.'s development and research laboratory, has been appointed to the Wiggin board and will take charge of technical (metallurgical) control and development in all the Wiggin plants. He is succeeded as superintendent of the laboratory by **Mr. H. Evans. Mr. R. E. Ansell,** manager of the Sales Department, now becomes a member of the Wiggin board. **Mr. O. Lewis Jones** will become general production manager, responsible for production in all the Wiggin plants. He is succeeded as works manager at Birmingham by **Mr. C. E. Winfield.**

Some changes at the Zenith Works, Glasgow, are also announced. The general manager, **Mr. A. B. Graham,** will relinquish this position on 1st July but will continue with the organization to undertake special duties in connection with production. He will be succeeded as Zenith works manager by **Mr. R. J. P. MacDonald.**

Mr. Sebastian Z. de Ferranti, the elder son of Sir Vincent Z. de Ferranti, has been elected a director of Ferranti, Ltd. He was educated at Ampleforth and served with the 4th/7th Dragoon Guards in Palestine. He received his practical training with the Alsthom concern, France, and Brown Boveri in Switzerland. He joined Ferranti, Ltd., on the staff of the Transformer Department in 1950. For the past two years he has been manager of distribution transformers and was appointed last year to a seat on the board of Ferranti Electric, Ltd., in Canada.

Mr. S. Z. de Ferranti

Mr. W. M. Bennett, A.M.I.E.E., has been taken into partnership by Messrs. Mackness & Shipley, consulting engineers.

Mr. H. P. White, B.Sc., has been appointed head of the Data and Publications Section of the Mullard Technical Service Department. Under the direction of Mr. T. H. Jones, head of T.S.D., one of Mr. White's principal responsibilities will be compiling and publishing technical data and information on the applications of Mullard valves and tubes. He has been in charge of the data and inquiries side of T.S.D. since 1949, before which he spent six years in the Mullard valve and applications laboratories. In future, Mr. White will combine the work of the data and inquiries service with that of the Technical Publications Department. **Mr. Harley Carter,** who was previously in charge of this department, will in future devote his entire time to the Mullard educational service. This now forms a separate department.

Mr. Maurice Tattersfield, A.C.A., F.C.C.S., has been appointed deputy general manager of the Loughborough works of the Brush Electrical Engineering Co., Ltd. He assumes his new duties this month and will be a member of the executive. Mr. Tattersfield joined the Brush group in January, 1953, as group controller of accounts.

Mr. E. G. Batt, who has just retired from the office of director and secretary of the British Refrigeration Association, asks us to say that personal correspondence should now be addressed to 34, Vernon Court, London, N.W.2 (Hampstead 2377). Official correspondence should be sent to his successor, Mr. T. Whittaker, at 1, Lincoln's Inn Fields, London, W.C.2.

Mr. Alexander Ramsay, B.L., at present town clerk of Barrhead, has been appointed secretary of the Clyde Sub-Area, S.W. Scotland Electricity Board.

Mr. J. T. Clewley, A.M.I.E.E., deputy Sub-Area engineer, Birmingham and District Sub-Area, Midlands Electricity Board, has been appointed

The gathering at the inauguration of the Research Station of A. Reyrolle & Co., Ltd. Lord Citrine is seated in the centre (see page 585)

engineer of the Wear Sub-Area, North Eastern Electricity Board, as from 1st May next.

Mr. F. W. Shelley has retired from the board of directors of Radio Rentals, Ltd.

Mr. L. G. Harris has retired from the position of manager of the Liverpool depot of the Simplex Electric Co., Ltd. He joined the company in Manchester in 1912 and, apart from service in the first world war, during which he was awarded the M.C., he has served the company for 42 years. In 1928 he was appointed manager for Scotland for Credenda Conduits, Ltd., and after the Simplex-Credenda amalgamation in 1932 he was appointed manager of the Heating and Cooking Department of the Simplex Electric Co. in London in 1934. He took over the Liverpool branch in 1938.

Mr. F. W. Bell succeeds Mr. Harris as manager of the Liverpool depot, where he has been deputy manager for the past two years. Before going to Liverpool three years ago Mr. Bell, who has been with the company for five years, was on the staff of the company's Bristol depot. Before the war he was with the West Gloucester Power Co.

At the annual general meeting of the Electrical Wholesalers' Federation on 18th March **Mr. W. Crisp,** of Young & Wildsmith, Ltd., London, was elected president of the Federation for the ensuing year. Mr. Crisp joined the council in 1950, and became the first London and Western section councillor. **Mr. R. E. Silvey** was re-elected section councillor of the South Western and South Wales Section, and was also elected vice-president. **Mr. E. J. Beaver** was re-elected as section councillor of the London and Eastern Section, and **Mr. A. Glenister** was elected section councillor of the Scottish Section, on the retirement of **Mr. G. W. Cartwright,** who has served on the Council for six years. Mr. Glenister served on the Council continuously from 1936 to 1951, and was president of the Federation in 1943-44.

Mr. W. Crisp

A collection made at the meeting on behalf of the E.I.B.A. resulted in £119 11s being presented to that Association's funds.

The Lord Mayor of Plymouth, Alderman Sir J. Clifford Tozer, and Lady Tozer were guests at the annual dinner at the Duke of Cornwall Hotel, Plymouth, on 23rd March, of the Plymouth Branch of the **Electrical Contractors' Association.** Proposing a toast to the Allied Associations and honorary officials, the Lord Mayor said that foreign competition was getting fiercer every day. There was an essential need for a return of the will to work and pride in craftmanship.

Mr. Hugh Molson, Parliamentary Secretary, Ministry of Transport and Civil Aviation, speaking at last week's annual luncheon of the Electric Light Fittings Association. On his left is the president, Mr. Cecil Hughes, and on his right Mr. N. V. Everton. On the left of the photograph is Mr. J. H. Campion, the secretary

In reply Mr. R. A. Marryat, vice-president of the E.C.A. and Allied Associations, said that unless they were able to achieve much greater output per man-hour they might not be able to maintain full employment.

A toast to the guests was proposed by Mr. H. Cousins, to which the city engineer, Mr. J. Paton Watson, replied. The toast of the Plymouth Branch was proposed by Mr. W. A. Miller, chairman of the Plymouth Housing Committee, who expressed gratitude to the E.C.A. for the high standard of the work and the help which it had given the city of Plymouth in the development of electricity. He criticized the prices of electrical appliances, which he said were much too high. Mr. F. R. Madge, chairman of the Branch, responded.

Foremen of the London Division of the **British Electricity Authority** held a dinner at Ergon House on 12th March, to express their appreciation of the supervisory training courses which have been organized at the supply industry's training centres at Horsley and Buxton. Over eighty foremen attended.

Mr. J. Graely, resident tutor at the Horsley Towers Training Establishment, was in the chair and guests included Mr. J. Eccles, C.B.E., M.M., deputy chairman (operation) of the Authority, Mr. H. V. Pugh, controller of the London Division, Mr. W. Wilde, chief generation engineer, and Mr. R. Meara, welfare officer.

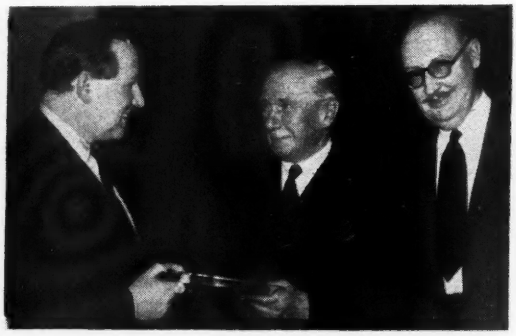
It was decided at the dinner to form a London Division Foremen's Association.

Mr. J. Eccles speaking at a dinner of B.E.A., London Division, foremen. On his right is Mr. W. Wilde, and on his left Messrs. Graely and Pugh

At the recent annual meeting of the Council of Ironfoundry Associations **Mr. N. P. Newman** was re-elected chairman, and Messrs. **Leonard Gould, F. D. Ley** and **H. V. Shelton** were re-elected vice-chairmen.

Mr. J. V. Daniel and **Mr. E. T. R. Ball** have been appointed directors of the British Electric Transformer Co., Ltd.

The annual dinner-dance of the **Leicester Electrical Society** was held at the Grand Hotel, Leicester, on 19th March, over 200 attending. Mr. K. L. Davies (chairman, Leicester Branch of the Electrical Contractors' Association) proposed the toast of the Society and spoke of the important part it played in the electrical life of the city. In his response, Mr. H.



Left to right: Sir Robert Renwick, Mr. W. J. H. Wood and Mr. L. E. W. Humphries

Walker, A.M.I.E.E., the president, appealed for continued support.

The chairman, Mr. K. Broom, A.M.I.E.E., proposed the toast of the guests and the ladies, and Mr. W. L. Sims, O.B.E., M.I.E.E., M.I.Mech.E., responded. The guests included Mr. D. H. Parry, B.Sc., M.I.E.E., manager of the Leicester Sub-Area of the East Midlands Electricity Board.

We have already reported that the A.S.E.E. award for the most outstanding industrial exhibit at the Electrical Engineers' Exhibition went to the English Electric Co., Ltd., for its "Superform" switchgear. The accompanying picture shows Mr. H. Simmonds, manager of the company's

Mr. H. Simmonds (left) receiving the A.S.E.E. silver plaque from Mr. C. T. Melling

Fusegear Section, receiving the award (a silver plaque) from Mr. C. T. Melling, president of the A.S.E.E.

At the end of last year **Mr. W. J. H. Wood,** M.I.E.E., M.I.Mech.E., retired on completing his term of office as a part-time member of the London Electricity Board. To mark the close of his long and distinguished career in the electricity supply industry, some 100 former colleagues of the County of London group of companies recently met to bid him farewell. Among those who paid tribute to Mr. Wood were Sir Robert Renwick, Bt., K.B.E., Sir John Dalton and Messrs. W. M. Booker, N. F. Gadsdon, C. L. Jaques and H. C. Wells.

Following training with the Phoenix Works and Cie Hydro - Electrique, Antwerp, Mr. Wood joined the Edinburgh Corporation as a junior assistant engineer in 1898. In 1900 he commenced a period of 27 years with the Bolton Corporation Electricity Department, for 14 of which he served as electrical engineer and manager. Joining the County of London Co. as engineer-in-chief in 1927, Mr. Wood was responsible for extensive generating, transmission and distribution schemes before being appointed director and joint general manager in 1945. At vesting day he joined the London Electricity Board as a part-time member.

OBITUARY

Dr. Frank Wenner, an internationally known physicist and geophysicist, died on 7th February. He had been active in consulting work at the United States National Bureau of Standards up to the time of his death. He was eighty-one. During his career he acquired an international reputation both in electrical measurements and in geophysics. His work on electrical resistance measurements included the development of a fundamental method for measuring the unit of resistance. The values assigned by international agreement to the electrical units derive in part from this work.

Mr. P. Tonks.—The death occurred on 24th March of Mr. Percy Tonks, joint managing director of the Revo Electric Co., Ltd.

He joined the company in 1920, and one of his early appointments was that of manager of the Manchester branch. In 1933 he returned to the head office at Tipton to become sales manager of the Domestic Appliances Section; he became a director of the company in 1950 and joint managing director in 1951.

Mr. Tonks was one of the earliest to popularize the electric cooker. He had been associatetd with the B.E.A.M.A. since 1935 and was a founder member of some of its committees, being chairman of the Domestic Electric Cooker Committee from 1948 to 1951 and a member of the B.E.A.M.A. Council since 1949. He also served on a number of B.S.I. Committees.

Mr. H. V. Benns, who died on 26th March after a long illness, was for many years on the staff of the B.T.H. Control Gear Engineering Dept. at Rugby. He was born in 1902 and joined the B.T.H. Co. as an engineering apprentice in 1917, subsequently serving for three years in the Test Department before joining the Control Gear Engineering Department. In 1946 he was a member of the B.E.A.M.A. team which went to Germany to investigate motor control gear production, and in 1949 he visited the United States in connection with his duties as a design engineer with B.T.H. Co.

Power Station Accident

A VERDICT of "Accidental death" was returned at a South Shields inquest on two men who were killed at South Shields power station when about to carry out repairs. The men were Ernest Mortimer (32), electrician, and R. Heron (41), electrician's mate. It was stated that the men had been given instructions to carry out repairs to No. 11 cubicle at the power station which had been isolated. In error No. 12 cubicle which was still alive was opened and there was an explosion in which the two men were killed and two others injured.

The coroner (Mr. F. A. Waller) said that the regulations had been ignored. The work card should have been given to the man in charge but it was not. It was also the duty of an authorized person to see that the apparatus was dead before work was commenced, but this had not been done.

Returning their verdict, the jury recommended that there should be separate keys for each cubicle and one master key; cubicles should be numbered on the inside as well as the outside of the doors; and warning lights should be fitted to each cubicle.

Stoke-on-Trent Contract Complaint

THE Potteries Branch of the Electrical Contractors' Association has sent a letter to the Town Clerk of Stoke-on-Trent, complaining that the City Council had awarded a contract for emergency lighting in local town halls to the Midlands Electricity Board without competition. The letter states that, even conceding the opinion of the Council that the matter was urgent, the Branch cannot see why competitive tenders were not obtained. Many local electrical contractors would have been prepared to submit estimates at short notice. The Association complains that this is the third occasion within the past two years on which the standing orders of the Council have been set aside and contracts awarded to the Midlands Electricity Board without competition.

E.H.V. Cable Testing

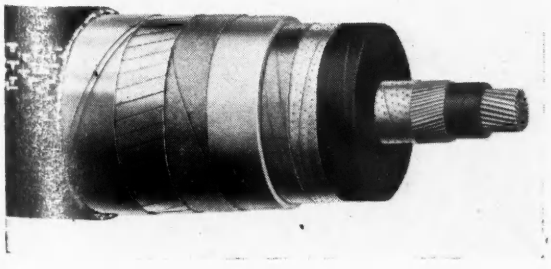
THE NEW B.E.A. STATION AT STAYTHORPE

THE British Electricity Authority inaugurated on 25th March a cable testing site adjacent to Staythorpe power station, where 275 kV cables will be tested under service conditions for a period of approximately two years. Although it may be some time before cables of this voltage are required commercially, it was decided that a testing site should be provided now, as the experience gained during the tests will be of great value to the B.E.A. and British cable makers. A number of leading British cable making organizations have answered the invitation through the Cable Makers' Association to submit 100 yd test loops of single core 275 kV cables, together with straight joints and sealing ends, to undergo intensive field trials, and although the nominal voltage of the cables will be 275 kV, they may be required to work continuously at 300 kV and should be able to pass an impulse test of 1,050 kV.

Three manufacturers, namely, British Insulated Callender's Cables, Ltd., Enfield Cables, Ltd., and Pirelli-General Cable Works, Ltd., have submitted test lengths, and these are connected in series with one phase of the 275 kV overhead line which links Staythorpe and West Melton. Isolating switches are provided on the site, so that any of the cables can be switched in or out of circuit as necessary. During the time the cables are on test the surges to which they are subjected will be measured by a surge recorder. Measurements of sheath temperature will be taken to ascertain the maximum temperature of the conductors during load cycles, and records will be kept of the voltage and load on the overhead line.

British Insulated Callender's Cables, Ltd., are submitting two lengths of cable—a 275 kV impregnated pressure cable and a 275 kV oil-filled cable. The impregnated pressure cable is designed to operate at a maximum stress at the conductor of 110 kV/cm, under a nitrogen pressure of 200 lb/sq in. As the overhead line to which the cable will be connected is only lightly loaded, a special type of conductor arrangement has been adopted so that the conductor will attain a temperature of 80 deg C, the maximum designed temperature for such cables operating under full load conditions. In all other respects the cable will be similar to those offered for commercial use.

The B.I.C.C. 275 kV impregnated pressure cable installed at Staythorpe testing station



Mr. F. J. Lane, transmission design engineer, B.E.A., inaugurating the Staythorpe cable testing station

The conductor arrangement of the cable consists of a stranded centre made up of 61/0·083in aluminium wires, covered with a paper separator over which is stranded a single layer of 47/0·066in aluminium wires which will actually carry the current, giving an effective conductor area of 0·16 sq in. This conductor is screened with metallized paper tapes over which the paper insulation is applied. The lead-alloy sheath is reinforced with tin-bronze strips applied both longitudinally and circumferentially, and an anti-corrosive protection of p.v.c., rubber and hessian is applied overall. The final overall diameter of the cable is 3·87in.

B.I.C.C.'s 275 kV oil-filled cable has also been designed to operate at a maximum stress at the conductor of 110 kV/cm. It consists of a 16 mm oil duct round which is formed the conductor, comprising 111/0·074in tin-bronze wires giving a conductor area of 0·46 sq in. As with the impregnated pressure cable, special arrangements were necessary to ensure the conductor attaining a temperature of 80 deg C. Tin-bronze wires were therefore used to give an increased resistance and consequent temperature rise. The conductor is screened with metallized paper tapes and over the paper insulation is applied a metallic screen and a copper-woven fabric tape. The lead sheath is 0·115in thick, giving the cable a diameter of 3·43in. The reinforcement comprises tin-bronze strips, and an anti-corrosive protection of p.v.c., rubber and hessian is applied overall. The final overall diameter of the cable is 3·64in.

The installation includes an impregnated pressure straight joint of a new type. The electrical design follows similar practice to that used for lower voltage impregnated pressure cables, but the cast plumbs have been replaced by a mechanical sealing arrangement and the inner lead sleeve has been omitted. The conductors are joined by a soldered flush-fitting ferrule, the overall diameter of the ferrule being equal to the diameter of the conductor. The impregnated pressure cable sealing ends consist of a condenser cone arrangement housed in anti-fog porcelains capable of withstanding the internal pressure of 200 lb/sq in. The condenser cone arrangement permits the use of a relatively small diameter of porcelain. The

straight joint and sealing ends for the oil-filled cable were specially designed for this installation, the sealing ends using the same type of porcelains as the impregnated pressure cable sealing ends.

Enfield Cables, Ltd., have submitted a cable which is the outcome of considerable experience gained with 220 kV self-contained compression cables installed at the Fontenay Testing Centre of the Electricité de France, and with an experimental cable which had been tested for many years in the high voltage laboratory of Enfield Cables, Ltd., at Brimsdown. The cable has an oval conductor of 0·4 sq in screened with carbon paper and is designed to withstand a maximum stress of 150 kV/cm under a nominal gas pressure of 250 lb/sq in. The dielectric thickness is 0·8in, the nominal loading is 200 MVA, and the actual loading is 120 MVA. With an overall diameter of 3·7in the cable weighs 16 lb per single core foot and a sample of it has withstood the company's standard impulse test of 1,050 kV. Since installation, the cable has been successfully subjected to a d.c. test voltage of 550 kV for 15 minutes.

The construction of the cable and joint follows the usual design for self-contained compression cables, and the cable is terminated in double-shed anti-fog pressure porcelain sealing ends. To comply with the electrical tests at the site, prefabricated condenser cones manufactured by Standard Telephones & Cables, Ltd., have been used to terminate the cable inside the porcelain. The normal compensator unit, gas filling valves and gas pressure gauges are provided.

The cable submitted by Pirelli-General Cable Works, Ltd., is a 275 kV cable of the oil-filled type. To match the overhead line, a prototype cable having a conductor size of 0·4 sq in was required but, since the transformers at present available will not fully load a cable of this size, a conductor of 70/30 brass wire has been used. This has enabled a cable to be designed having the necessary electrical and mechanical characteristics to meet the trial installation conditions with negligible change in conductor and insulation from the standard 0·4 sq in cable.

The conductor is screened and lapped with paper tapes giving a dielectric of graded construction which is externally screened with metallized paper and single lead sheathed. The lead-alloy sheath is reinforced with bronze tapes and protected overall with an anti-corrosive serving. The final overall diameter is 3·18in. The straight joint and two sealing ends which form part of the Pirelli-General installation have been designed in the light of experience gained with the 301 kV cables made recently for the Aluminum Company of Canada, Ltd.

Mr. F. J. Lane, transmission design engineer, B.E.A., carried out the inauguration ceremony at which there were also present Mr. H. R. Schofield, transmission construction engineer, B.E.A., Mr. A. J. Gibbons, plant and equipment design engineer, B.E.A., Mr. C. H. Broughton Pipkin, manager home sales, British Insulated Callender's Cables, Ltd., Mr. A. M. Morgan, chief assistant test and research engineer, Enfield Cables, Ltd., and R. J. Willoughby, manager, power cables sales department, Pirelli-General Cable Works, Ltd.

Taping joint on Enfield 275 kV cable

COLOUR TELEVISION

IN a lecture to the Radio Section of the Institution of Electrical Engineers on 22nd March, Mr. C. J. Hirsch referred to the N.T.S.C. compatible colour television as adding colour to black and white (luminance only) pictures, the latter still being receivable by ordinary sets. Colouring information (" chrominance "), he said, was transmitted on a sub-carrier simultaneously phase-modulated to carry dominant wavelength and amplitude-modulated for purity. Chrominance could be transmitted with about one-third less band than luminance. Colouring information was transmitted within the same spectrum band as the black and white, with which it was " frequency-interleaved." Colour receivers had the additional circuits required to extract the interleaved colour information and add it to the luminance picture.

In the ensuing discussion (to which eight speakers contributed) it was mentioned that in the United States colour information in a compatible system occupied only 4 Mc/s of bandwidth. Doubts were expressed as to the feasibility of adapting the N.T.S.C. colour system to conditions in Great Britain, where the central problem was the best use of available wavebands. One speaker estimated that the N.T.S.C. system would require about 30 per cent more power from British transmitters, which would involve considerable capital expenditure.

Indian Automatic Telephones

THE change-over from the manual to the automatic telephone system in Calcutta, undertaken by the Government of India with the assistance of the G.P.O., England, is estimated to cost Rs 13·40 crores (about £10 million). A provision of Rs 1·50 crores has been made for the current year while nearly Rs 3·50 crores had been spent up to April, 1952, on this big project. The first stage of construction has already been completed. There will be three exchanges with a combined capacity of 14,000 lines: these are expected to be put into operation by the middle of this year. The G.P.O. officers whose services have been placed at the disposal of the Indian Posts and Telegraphs Department through the Colombo Plan of Technical Co-operation are Mr. D. J. W. Kennedy, Mr. J. G. Partridge, Mr. J. W. Moore and Mr. W. G. Drury.

PARLIAMENTARY REPORT

By 296 votes to 269 the Government last week obtained a second reading for the Television Bill.

Sir David Maxwell Fyfe, the Home Secretary, in moving the second reading, said it was not the intention of the Government that the new Authority (I.T.A.) should enter into the programme making business and build up a large organization of its own. The powers of the Authority to provide programmes were strictly limited, and there was no scope for it to get rid of the programme contractors altogether and become a State trading organization or a new B.B.C.

Mr. Herbert Morrison, moving the rejection, said that the whole of the scheme was highly objectionable. The Labour Party must reserve the right to modify, or, indeed, abandon the entire scheme and that might well include the complete elimination of the proposals for advertising.

Mr. Hobson, opposing the Bill, said that the recommendations of the Television Advisory Committee were thoroughly unfair to existing television users and to users of v.h.f. commercial radio, as well as inimical to the furtherance of television on other wavebands.

He did not think sufficient attention had been given to the cost of the needed alteration to sets to make the second programme available. They had been told that the alterations would cost between £5 and £6, but his estimate was that it would be nearer £9.

Mr. Gammans, the Assistant Postmaster-General, said that the two channels in Band III which the Government proposed to allocate to commercial television would be sufficient without any others to give coverage to Wales and also to Scotland.

National Fuel Policy

Mr. A. M. F. Palmer asked the Minister of Fuel and Power which of the major recommendations of the Committee on national policy for the use of fuel and power resources had now been carried out.

Mr. Joynson-Hicks said that of the Committee's 14 major recommendations 12 had been carried out in whole or in part. Recommendations 39 and 40 were not accepted but alternative action had been taken to achieve their underlying purpose.

New Generating Plant

Mr. Palmer asked the Minister of Fuel and Power if he would state the estimated capacity of obsolete electrical generating plant of low efficiency proposed to be replaced by modern high efficiency plant in the next ten years, the estimated capital cost, and the approximate saving in fuel consumption.

Mr. Joynson-Hicks said that the development of the industry envisaged the commissioning of some 17,000 MW of new high efficiency power station plant in the next ten years costing at present prices over £1,000 million. Reduction in the output from old plant would depend upon the increase in demand for electricity and therefore the saving in fuel consumption could not be estimated.

Smoke Pollution Prevention

Mr. Popplewell asked the Minister of Fuel and Power if he would express in percentage figures the effectiveness of each chimney at Dunston power station, County Durham, in the prevention of dust and smoke pollution; and if he would state the type of installation to prevent dust and smoke pollution in each chimney at the power station in question.

Mr. Joynson-Hicks said he was advised that the cyclone grit arrestors on chimneys 1 and 2 were working at 73 per cent efficiency, those on chimneys 3 and 4 at 68 per cent, and the electrostatic precipitators on chimneys 5 and 6 at 97 per cent.

In the Courts

Unguarded Power Press

At Loughborough (Leics.) Magistrates' Court on 24th March a fine of £100 was imposed on the Brush Electrical Engineering Co., Ltd., for failing to fence a power press at its works in Nottingham Road. Mr. J. J. Schofield said that when he was using a power press on 18th February he thought it needed some adjustment and stopped the motor. While making the adjustment the press came down and smashed a finger of his right hand; the finger was later amputated. This machine, it was stated, had no guard.

Claim Reduced

In February at the Colchester Magistrates' Court the Eastern Electricity Board applied for a committal order against Mr. L. S. Lowe, of The Cardinan, Green Lane, Great Horkesley, following a judgment for £46 obtained in 1949 in respect of an unpaid electricity account. The case was then adjourned, defendant having drawn attention to the fact that another Court had refused to make an order in similar circumstances because the judge held that meters could be faulty. When the matter came before the Court again on 16th March the claim was reduced to £10, the application before the Court being for a judgment summons for that amount. It was stated that Mr. Lowe had agreed to pay this sum at the rate of 10s a month. A committal order for 21 days was made, sentence being suspended while the instalments were paid.

Damage Claim for Shock

In the Queen's Bench Division last week Mr. Justice Finnemore heard a claim for damages for negligence by Mr. Harris Shapiro (Stepney) and his wife against Mr. D. Jay, trading as "Jay's for Wireless" at Commercial Road, London, E. The plaintiffs' case was that Mr. Jay was asked to repair a portable radio set. The set was repaired and returned and was placed on a metal shelf in the Shapiro's kitchen. Later Mrs. Shapiro took a bath in the bathroom adjoining the kitchen. Upon attempting to place a towel on a towel rail she received a severe shock. She was removed from the bath by Mr. Shapiro who also sustained a shock when he took the towel from the water. It was stated that the towel rail was connected with the shelf in the kitchen which had become electrified because of a defect in the radio set.

Mr. Jay denied that he had been asked to repair the set. Mr. Shapiro had once complained that reception was being interfered with and he had sent an assistant to listen but the set had not been repaired or removed from the flat. The assistant, giving evidence, said that Mr. Shapiro had asked him to move the set from the dining room to the shelf in the kitchen.

After a three-day hearing Mr. Justice Finnemore reserved judgment.

Exhibition Competition

As a result of the electricity consumption estimating competition at the Electrical Engineers' Exhibition at Earls Court nearly £60 was collected in aid of the Electrical Industries' Benevolent Association. The actual electricity consumption at the exhibition was 445,819 kWh and the three nearest estimates were 445,509, 444,444 and 442,628 kWh.

INDUSTRIAL NEWS

Brazilian Railway Contract

ONE OF THE largest contracts for electric railway equipment ever placed has been awarded to the Metropolitan-Vickers Electrical Co., Ltd. The Central Railway of Brazil has ordered two hundred complete railway coaches to be built and equipped in this country and a hundred sets of electrical equipment for fitting to coaches built in Brazil. These will provide one hundred new three-coach trains for the Rio de Janeiro suburban lines.

This contract, which is financed in part by an International Bank loan of $12,500,000 and is worth about £7,000,000, was obtained for Britain in the face of severe foreign competition. Bids were put in from the United States, France, Belgium, Holland, Germany, Switzerland and Japan, as well as from Brazil itself. The electrical equipment involved will be made at the Metropolitan-Vickers factories at Sheffield and Trafford Park, Manchester, and the coaches will be constructed at the Metropolitan-Cammell Works at Saltley, near Birmingham. It is expected that the contract will be completed by the end of 1957, when the Central Railway will have a total of nearly six hundred electric coaches. These will involve the servicing of a large amount of specialized electrical equipment, for which purpose a special factory is now being built by Metropolitan-Vickers in Brazil.

The Central Railway of Brazil electrification is on the 3,000 V d.c. system. The trains are made up of one or more three-coach sets, each set comprising two trailer coaches with a motor coach in between and being capable of driving from either end. The motor coaches are equipped with four traction motors, each rated at 320 h.p. (one-hour rating) at 1,500 V, giving a total of 1,280 h.p. per motor coach; the motors are permanently connected in pairs in series. The control is electro-pneumatic. The maximum speed of the new trains is 53 m.p.h. They are of somewhat greater power than the existing rolling stock, but old and new coaches will be used together in multiple unit, thus enabling the service to be speeded up.

Engineering Wages Claim

Delegates from the unions affiliated to the Confederation of Shipbuilding and Engineering Unions met on 24th March to consider their next move following upon the rejection by the unions of the engineering employers' offer of a 5 per cent increase in wages—against the 15 per cent which had been claimed. After prolonged discussion it was agreed that another meeting should be sought at which the employers would be asked if they were prepared to offer more than 5 per cent. If they were not a further meeting of the unions would be called to consider what action should be taken to enforce their claim.

A letter was sent to the Confederation on Thursday last week by the employers' Federation giving reasons why a higher offer than 5 per cent was not possible. The employers offered to meet the union representatives on Monday last if the unions had any new information bearing on the subject.

The employers maintained that they were not justified in conceding any increase in view of the serious decline in orders in the face of increasing foreign competition.

Electricians' Wages

It was announced last week that the Minister of Labour had referred the wages dispute in the electrical contracting industry to the Industrial Disputes Tribunal for Arbitration; it is expected that the Tribunal will hear the parties' cases early next week.

Closing of Non-Ferrous Metals Directorate

The Ministry of Materials has announced that as from 23rd April next the remaining duties of the Directorate of Non-Ferrous Metals at Rugby will be taken over by the headquarters of the Ministry of Materials, Horse Guards Avenue, London, S.W.1, and correspondence should be addressed accordingly.

Plumber Jointers' Pay

At its meeting held on the 17th March the Joint Industrial Council for the Electrical Cablemaking Industry decided that the rates for plumber jointers should become consolidated as from the beginning of the first full pay period following 17th March, on the understanding that such consolidation shall not prejudice any local arrangements at present obtaining for the payment of bonuses related to results. The consolidated rates for plumber jointers as from the above pay period will, therefore, be:—4s 0¼d an hour in the London area and 3s 8¾d an hour throughout the rest of the country.

"The First Five Years"

At this year's British Electrical Power Convention each delegate will be given a copy of a booklet bearing the above title in which the proceedings of the first five Conventions will be summarized. This will form a useful record of the valuable papers presented by leading electrical authorities and give a good idea of the contribution which the Conventions have made to electrical progress.

Lord Citrine, to whose initiative the continuance of the I.M.E.A. Conventions in the new form was largely due, provides a foreword and there is a message from Mr. J. R. Beard, this year's president of the Convention.

Copies of the booklet will be available to others than delegates at 2s each, obtainable from the secretary, Mr. J. W. Simpson, Winsley Street, London, W.1.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM Ingots	ton £156 0s 0d
COPPER, H.C. Electro	ton £235 10s 0d
Fire Refined 99·70%	ton £234 0s 0d
Fire Refined 99·50%	ton £233 0s 0d
COPPER Tubes ..	lb 2s 3¾d
Sheet	ton £292 0s 0d
H.C. wire and strip	ton £263 0s 0d
LEAD, English ..	ton £91 5s 0d
Foreign	ton £90 0s 0d
MERCURY	flask £69 0s 0d
TIN, block (English) ..	ton £727 10s 0d
ZINC, G.O.B. Foreign	ton £79 10s 0d
Electrolytic	ton £81 10s 0d
BRASS Tubes (solid drawn)	lb 1s 10¾d
Sheet	ton £238 15s 0d
Wire	lb 2s 5½d
PHOSPHOR BRONZE Wire	lb 3s 8¾d
PLATINUM	oz £30 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 16¾d–16¾d

Revised Tungsten Ore Prices

The Ministry of Materials announces that from 26th March its selling prices for tungsten ores of standard 65 per cent grade and ordinary quality have been increased as follows:—Wolframite from 120s to 130s; Scheelite from 115s to 125s per long ton unit delivered consumers' works.

Dual Colour Lamp Demonstration

At the Central Hotel, Glasgow, last week the Dalzell Electric Welding Co., Ltd., demonstrated its "Dewlite" electric lamp which has a double filament enabling two colours to be shown simultaneously or separately. Any two-colour combination can be supplied. There is a screen between the differently coloured sections so that the colours cannot intermingle. The lamps can be manufactured in voltages to suit special requirements and the two sections need not be of equal wattage. Applications include a dual purpose spotlight and foglamp for motor vehicles, a combined white headlight and dipped amber light, reversing and stop lights, signalling lamps for aircraft, shipping, railways and industry, and a combined ordinary room and subdued amber televiewing light. Where coloured lamps are used for advertising, the lamp could halve the number required, or increase the colour combinations.

Wireless and Electrical Year Book

The 1954 edition of the *Wireless & Electrical Trader Year Book* includes condensed specifications of more than 250 current commercial television receivers and information on valve and cathode ray tube base connections, with over 300 valve base diagrams. A new feature is the complete text of the wages agreement covering radio and television service engineers, together with details of the rates of pay for radio and television shop managers and assistants.

Other data includes specifications of over 300 current radio receivers, legal and licensing information and a directory of trade associations. The pages of the directory sections are distinctly tinted for easy reference.

The Year Book (296 pp.) is published at 10s 6d (postage 6d) with a reduction to subscribers to *Wireless & Electrical Trader*, by the Trader Publishing Co., Ltd., Dorset House, Stamford Street, London, S.E.1.

Seventy-fifth Anniversary

To mark the 75th anniversary of the inception of Thos. W. Ward, Ltd., the company has published a book of over 200 pages describing the growth of its group of companies, with many excellent illustrations of the company's various works and products and installations carried out.

Transformer Factory Lighting

The factory of Ferranti, Ltd., at Hollinwood, Lancs., provides a typical example of the advantages of 8ft fluorescent lighting in heavy industry where products of large dimensions are built in shops with very high ceiling. Mr. E. Morris, of Ferranti, Ltd., decided to make exhaustive tests with a number of light sources. He was anxious not only that the economics of the installation should be studied, but also colour rendering and brightness. "Metrovick" illuminating engineers were invited to co-operate with a view to providing the most suitable illumination for this new transformer factory. In building large transformers a high value of vertical illumination is necessary and it is important to be able to see easily into the many recesses in the structures. Colour discrimination is essential with the many and varied materials used. To clear the overhead travelling cranes, high mounting heights of 64ft in the high bays and 40ft in the low bays have to be taken into account. The final decision was in favour of an 8ft 125 W hot cathode scheme.

The installation was planned for an average of 15 lumens per sq ft and 1,800 lamps are used mounted in heavy gauge metal trough reflectors with upward light slots. Each unit has a separate 3-pin plug and socket to enable the maintenance staff to remove or replace any fitting quickly for cleaning or overhaul.

The feeder bay, small assembly, of Ferranti's transformer factory, Hollinwood, in which "Metrovick" fluorescent lighting is used

North Western Board Strike

A strike by more than 100 workers at the Ardwick, Manchester, depot of the North Western Electricity Board which began on 22nd March ended on the following night. The strike followed a notice by the management which the workers claimed would result in semi-skilled men being employed on the dismantling of water heaters. A number of men at a Salford depot also joined in the strike. After the dispute had been considered by the District Joint Industrial Council for the Electricity Supply Industry in Manchester it was announced that the management had agreed to withdraw the notice subject to a complete resumption of work at all depots. The Board has agreed to meet the trade unions concerned over the issue.

Braille Cookery Book

A ceremony took place recently in the Christian Institute, Glasgow, when

Mr. J. Gogan, chief commercial officer, South West Scotland Electricity Board, presenting a copy of the Braille cookery book to Prof. W. J. Brownlow Riddell

Prof. W. J. Brownlow Riddell, of Glasgow University, accepted on behalf of the Mission to the Outdoor Blind, of which he is president, some 200 copies of a new electric cookery book printed in Braille. The books were given by the South West Scotland Electricity Board, whose chief commercial officer, Mr. James Gogan, formally handed them over to Prof. Riddell. After the presentation, a specially adapted electric cooker was demonstrated to the audience of blind people.

Lift Company's Centenary

Founded in 1854 by Jonathan Pickering who was born in 1826 and died in 1891, Pickerings, Ltd., is one of the oldest engineering firms on Tees-side. Jonathan Pickering was the inventor and patentee of the original Pickering pulley block with which he established his reputation. Further improvements in hoisting appliances developed as time progressed, and the company successfully exhibited its products at Bremen, Germany (1874), Philadelphia, U.S.A. (1876), and Amsterdam (1888). In 1887 the firm was incorporated as a limited company and was one of the first concerns in the country to commence manufacture of lifts. Its first electric lift was made in 1888 and installed at premises of the Middlesbrough Co-operative Society, Ltd., and the first fully automatic push-button lift was made in 1896.

In addition to lifts of all kinds the company makes handling plant and furnace charging machines. During the 1914–18 war and the last war much work of national importance was carried out. The centenary coincides with fifty years' service of its present chairman, Mr. J. Fothergill. There are also three employees still serving who have been with the company for over fifty years.

New Cable Ship

A new cable repair ship will be launched at Newcastle-on-Tyne on 3rd May. She is the c.s. *Recorder*, of about 3,300 tons, now being built for Cable & Wireless, Ltd., by Swan, Hunter & Wigham Richardson, Ltd., at their Neptune Yard. She will be

the largest ship in the company's fleet. The ship will be named by Mrs. L. B. Nicholls, the wife of Major-General L. B. Nicholls, chairman of Cable & Wireless, Ltd.

When the ship is commissioned in the late summer she will be commanded by Captain Charles C. Muckleston, who has served in six of the company's fleet of eight cable ships. He was previously in command of c.s. *Lady Denison-Pender*. The new ship will be stationed at Singapore, from which base she will maintain the 20,000 miles sections in the Indian and Pacific Ocean areas of Cable & Wireless, Ltd.'s 150,000 miles British Commonwealth cable system. The cables she will help to maintain include the longest continuous submarine cable in the world. It stretches the 3,466 miles between Bamfield (Vancouver) and Fanning Island, in mid-Pacific. This vessel will be the third cable ship to be named *Recorder;* the last was broken up in 1952 after fifty-five years' work in the area in which her successor will serve.

West Bridgford Contract

In our issue of 26th March we stated that Messrs. Cecil Howitt & Partners, Nottingham, were the architects for an estate of approximately 1,000 houses at West Bridgford, Nottingham. Messrs. Howitt inform us that although they were responsible in the first instance for the layout of the site, they are in no way concerned with the building scheme, which is in the hands of the owners, Arthur Short Estates, Ltd.

Steels in Power Production

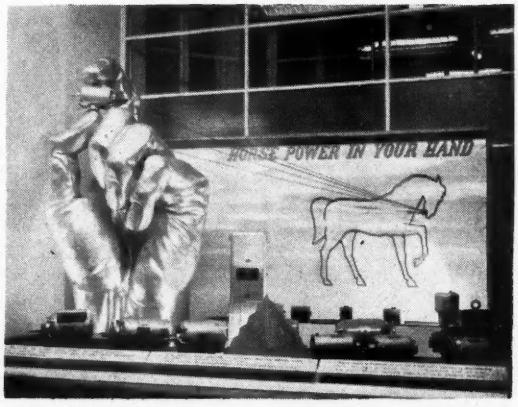
A new film, with a spoken commentary, entitled " Stainless Steels in Power Production " was shown in London for the first time on Friday last. The film, in " Kodachrome " colour, was made by Firth-Vickers Stainless Steels, Ltd., Sheffield, and shows examples of the various applications of " Staybrite " steels to a number of industries, including the welding of steam turbine blades, hydro-electric plant, gas turbines and jet aircraft. The 16mm film, which runs for 31 minutes, is available on loan.

Brook Motors Jubilee

Next month Brook Motors, Ltd., celebrates the fiftieth anniversary of its foundation. It was in May, 1904, that Mr. Ernest Brook began making a.c. motors in one room with two assistants and a capital of £300. The business was formed into a limited company in 1951 and last year's turnover had a value of £4½ million.

There are ten factories at Huddersfield and a new plant at Barnsley which together cover nearly a million square feet.

An extensive selling organization has been built up in this country and overseas. In the United States a separate company, the Brook Motor Corporation, Chicago, was formed last year.



One of a series of window displays recently arranged at the London office of Brook Motors, Ltd., at Palmer Street, Westminster

To mark the jubilee a special gratuity scheme is being provided against their retirement for all employees not in the company's pension scheme. Also an outing to Llandudno for employees and their relatives and friends has been arranged for 21st May. The new Barnsley factory will be officially opened on 28th May.

Modernized Showrooms

The Crowborough showrooms of the South Eastern Electricity Board have been modernized and enlarged and Mr. John Simons, J.P., chairman of the Parish Council, was last week invited to reopen the showrooms. Mr. N. Boydell, sub-area manager, introduced Mr. Simons at the opening ceremony which was attended by Major F. Springate, deputy district manager (in the absence through illness of Mr. T. W. Dann, manager, Tunbridge Wells District), Mr. G. H. Ingamells, sub-area commercial engineer, Mr. R. E. Gleadow, district commercial engineer, and other members of the staff.

The showrooms were originally opened in April, 1928, shortly after the acquisition by the Weald Electricity Supply Co. of what was then the Crowborough Gas and Electricity Supply Co. The modernization, enlargement and redecoration of the showrooms in the Broadway will now provide increased facilities for display and demonstration of electrical equipment of the type that will appeal to what is chiefly a domestic and agricultural community.

Battersea Polytechnic Extensions

On Friday last the formal opening of the extensions to the Battersea Polytechnic was performed by the Princess Royal. Afterwards, accompanied by the chairman and the Mayor of Battersea, she made a tour of inspection of selected parts of the extensions which comprise a new east wing, Great Hall block and gymnasium block. As a result of the present extensions and adaptations, the electrical engineering department is completely rehoused and now occupies three floors of the gymnasium block. Much new equipment has been installed and it is estimated that the floor space of the electrical engineering department has been increased by more than 50 per cent.

The total estimated cost of the extensions, including equipment and furniture, is £384,116, the whole of which has been provided by the London County Council. The main contractors were James Carmichael (Contractors), Ltd., and electrical work was carried out by Thorpe & Thorpe, Ltd.

Brush Group Sales Conference

The Brush group's biennial sales conference will be held at Wadham College, Oxford, from 7th to 10th April. It will be attended by more than 50 directors and executives from all over the world.

Trade Announcements

Panelec (Great Britain), Ltd., is moving on 20th April to 27, Hatchlands Road, Redhill, Surrey. The telephone number will remain unaltered.

Mr. Leslie Maynard, 13a, Gillingham Street, London, S.W.1, has relinquished the agency for **W. T. French & Son, Ltd.,** and Mr. J. H. Shirley, 46, Cornwallis Road, London, N.9 (telephone: Tottenham 7427), is now the company's agent covering London, the home counties and southern counties.

Viking Lamps, Ltd., inform us that its agency arrangement with Ensel Electric Co., Ltd., has expired and is not to be renewed in view of the company's intention to open a London depot. Pending the acquisition of suitable premises, all orders and inquiries for fluorescent lamps should be forwarded to the factory, at 14, Stanley Road, Bradford, 2.

Catalogues and Lists

Uncles, Bliss & Co., Ltd., 139, Cherry Orchard Road, East Croydon, Surrey.—28 p. illustrated priced catalogue of electrical appliances and television and radio receivers, tape recorders, etc.

Grampian Reproducers, Ltd., Hanworth Trading Estate, Feltham, Middx.—Illustrated price list of " Grampian " sound equipment.

Automatic Telephone & Electric Co., Ltd., Strowger Works, Liverpool, 7.—Technical publication relating to carrier channelling equipment for radio routes (REB. 102).

English Electric Co., Ltd., Fulwegear Works, East Lancashire Road, Liverpool, 10.—Illustrated catalogue dealing with the new English Electric " Superform " distribution equipment.

TRANSISTORS

n-p Junctions in Semi-Conductors

By P. L. DEGEN, B.Sc.(Hons.), A.Inst.P.

IN 1948 the first announcement was made of an effect enabling a power gain to be obtained from an amplifying device containing no vacuum envelope and requiring no heater power, and the name of "transistor" was given it.[1, 2] Since then development has been continuous, the greatest diversity being among those forms known as "junction transistors," first announced in 1951.[3, 4] Fields in which various types of transistors are immediately or potentially useful include telephone exchanges and electronic switching gear generally, highly miniaturized transmitters, receivers and r.f. power supplies, and photocells. The number of organizations actively investigating the possibilities is still growing, and the pace of development increases accordingly.

The point-contact transistor has now been known for five years; Fig. 1 illustrates the construction: two electrodes of tungsten wire 0·005in or a little less in diameter are electrolytically etched to give them a fine point of 0·001in radius and spot-welded to lead-in wires. Crimped in a plane perpendicular to the paper in order that a light spring pressure may be maintained, they are in contact with the surface of a small piece of n-type germanium. (This term will be explained later.) This is soldered to a conducting base, making a low-resistance connection, and the surface is first highly polished, then lightly etched, as in the case of a point contact diode. The two tungsten wires, or "whiskers," are in close proximity; the spacing is of the order of 0·001 to 0·002in. If one of these electrodes, the "collector," is given a moderate negative potential, a small current will flow between it and the base, as in the case of a point contact rectifier biased in the reverse direction. If a small positive bias (of the order of tenths of volts) is applied to the other electrode (the "emitter") a current flows from the emitter into the germanium. An increase in the collector current occurs, and the ratio of this increase to increase of emitter current is the current gain, α. This may be greater or less than unity, and since the collector current flows through a high impedance, while the input impedance is lower, voltage and power gain are obtained. The earliest transistors produced by the Bell Telephone Laboratories were of this structure, and were known as "Type A."

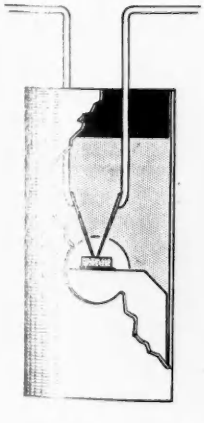


Fig. 1.—Type A transistor construction

One of many possible equivalent circuits is given in Fig. 2: r_e, r_c are very nearly the a.c. forward and reverse impedances of the rectifying barrier layer; r_b is the feedback impedance and "a" is very nearly α, the current gain. Average circuit element values of the Type A transistor were:—$r_e = 250\,\Omega$, $r_c = 20{,}000\,\Omega$, $r_b = 250\,\Omega$, $a = 2$. However, these values varied widely: r_c and r_b within a range of 7 : 1, r_e 3 : 1 and "a" 4 : 1. Development since 1948 has led to a greatly increased control over the manufacturing process, and in the case of the M1729 transistor of early 1952, Morton[1] writes of circuit constant values which were approximately the same, but with a variation of about $\pm$ 20 to 30 per cent.

At the same time, the reliability has been greatly improved as compared with earlier models. Life tests have been in progress throughout: in January, 1952, a half-life of 70,000 hours was estimated on the basis of two years' life-testing as Class A amplifiers, and subsequent improvement may be assumed. The effect of temperature has also been reduced. Semi-conductors, as will be explained below, have high temperature coefficients of resistivity, and the principal effect in the case of a transistor is a decrease in the collector resistance, r_c. This has been reduced from 1 per cent per deg C to $\frac{1}{4}$ per cent per deg C.

Resistance to shock is now good; shock tests of up to 20,000 g, and vibration tests up to 1,000 g being withstood, whilst the size, already notably small in the earliest models, is now down to 1/2,000 cu in. Finally, the power supply requirements have been reduced so that whereas in 1949 a collector voltage of about 30 was necessary in order to obtain useful gain, by 1952 this requirement was reduced to 2–6 V for point-contact transistors, while junction transistors will deliver useful gain for a collector voltage of less than 1 V. Collector power required is 2–10 mW and 10–100 μW respectively.

Point-contact transistors at present on sale in this country operate with collector voltages up to a maximum of 30–50 V, and a maximum dissipation of 100–120 mW. Ambient temperatures up to 55 deg C are tolerated, and the frequency cut-off occurs around 1 Mc/s. Junction transistors require collector-emitter voltages up to 4 V (maximum) for a collector current of 0·5 mA.

Conduction in a Semi-Conductor

These improvements have largely been made possible by an increased understanding of the basic processes involved, and this has, in fact, led to the development of a quite new device, the junction transistor.

An atom of germanium (or silicon, an element chemically

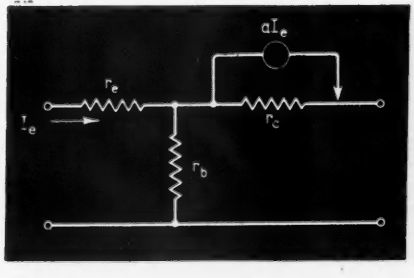


Fig. 2.—Transistor equivalent circuit

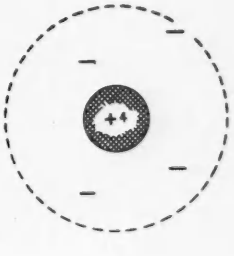


Fig. 3.—Charge distribution in an atom of silicon or germanium

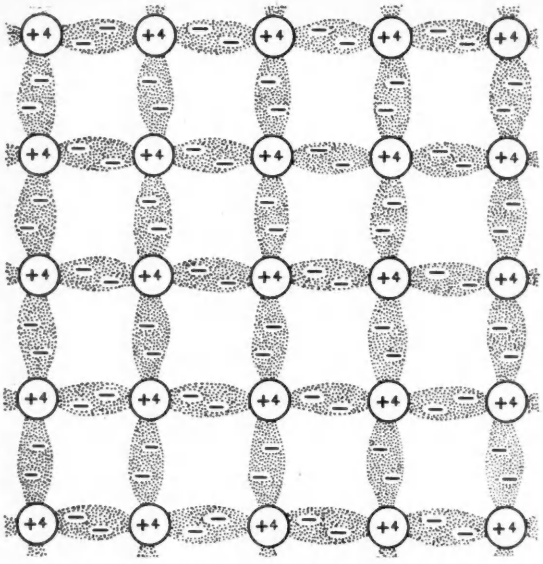


Fig. 4.—Two-dimensional representation of the germanium crystal lattice

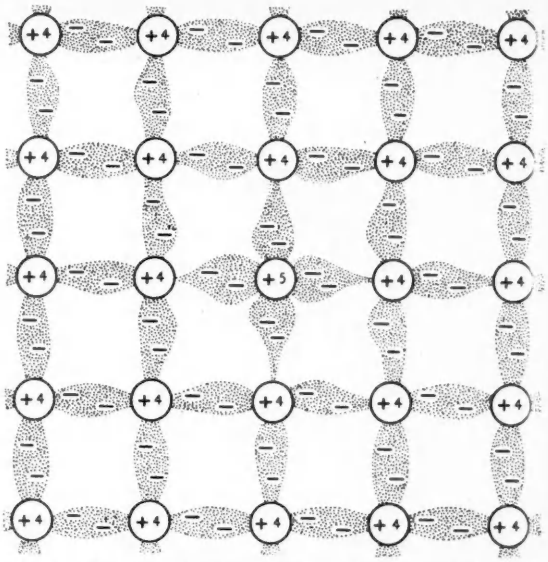


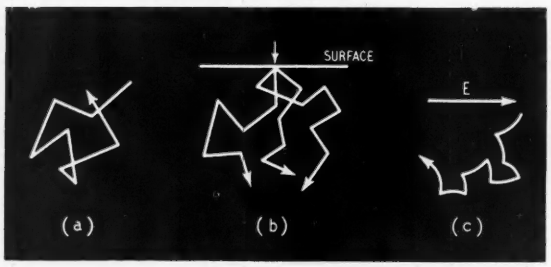
Fig. 6.—Two-dimensional representation of the germanium crystal lattice containing an impurity atom

similar, and also showing rectification and transistor action) consists of a positively charged nucleus and a number of tightly bound electrons, the whole having a net charge of + 4 electron units, plus four more loosely bound electrons —the " valency electrons " of chemistry. This can be represented as in Fig. 3. In a crystal, one electron from each of two adjacent atoms together form a co-valent bond, so that the crystal structure of germanium may be represented two-dimensionally as in Fig. 4.

If an extra electron is introduced into a perfect array of atoms of this sort, it does not partake of any of the bonds, but will wander about. The fact that it can, as a charged particle, penetrate the high local electric fields of the lattice, as the crystal structure is termed, is a result of the properties of these fundamental particles, as expressed in wave mechanics. At any temperature above absolute zero (— 273 deg C) the lattice of atoms will be vibrating, and electrons will be reflected by these vibrations, so that a random motion results, as in Fig. 5a, the average distance travelled between reflections being the mean free path.

If now a number of electrons are injected into the crystal at any particular point, they will diffuse into it as in Fig. 5b. Further, if an external electric field is superimposed upon the periodic lattice field there will be a drift component of the electron velocity, in a direction opposite to that of the field. (Fig. 5c.) The effect of the successive collisions of the electron with the lattice vibrations is that a constant average drift velocity is attained and this will constitute a current flow. From measurements of this current the mobility, or velocity per unit field, can be calculated; for germanium it is 3,600 cm^2/volt sec.

Fig. 5.—Motion of electrons in a crystal of a semi-conductor: (a) in the body of the material; (b) injection at the surface; (c) electrical field superimposed



A quite different mechanism of conduction results if, instead of adding one electron to those in the bonds, an electron is removed from one of them. There is now a region in the crystal lattice where one unit of negative charge is missing. An electron from an adjacent bond can fill this gap, thus leaving a gap in its previous position. In fact, the gap, or " positive hole " as it is called, moves about in the lattice like a positively charged particle. It would appear from this description that the positive hole would have much lower mobility, and shorter mean free path. The mobility is about half that of an electron, however, and a more refined theory in fact predicts this.

The bonds between atoms in the lattice may be considered to have a certain strength. If an amount of energy E is applied to a bond, it will break, ejecting an electron, and leaving a positive hole behind, both of which will migrate through the crystal and give it electrical conductivity. The frequency with which this occurs depends on the thermal energy of the material and it increases very rapidly with the temperature, the conductivity being of the form:

$$\sigma_1 = Ae^{-\frac{E}{2kT}}$$

where k is Boltzmann's constant, and σ_1 is the intrinsic conductivity. In some semi-conductors (of which graphite is a striking example) it may be very high at room temperature, but in germanium and silicon room temperature conductivity occurs through another mechanism.

Suppose that in place of one of the Ge atoms (net charge + 4) an atom such as arsenic which has a net charge of + 5 is substituted. The situation will now be as in Fig. 6. The polarization of the bonds results in a shielding of the extra positive charge so that the attraction for conduction electrons is slight. If there are a large number of these atoms dispersed throughout the crystal there must be, in order to retain electrical neutrality, a compensating number of excess electrons. We should not expect to find a large number of holes existing in the presence of excess electrons: in fact, the concentration of holes:—

$$p = n_1^2/n$$

where n_1 is the concentration of electron-positive-hole

pairs to be expected in the absence of the impurity, and n is the concentration of impurity atoms or " donors." The specimen is described as " n-type." The concentration of donors, n, is typically of the order of 10^{15}/c.c.

A different mechanism of conduction occurs if atoms having a valency of 3 are substituted in the germanium or silicon lattice. In this case the atom has only three electrons available for bond-forming, and an incomplete bond containing a positive hole is the result. An electron completing the bond causes the hole to migrate away from the substituted atom, or " acceptor," and in the neighbourhood of the acceptor the bonds are polarized as in Fig. 6 but, of course, in the opposite sense. Material of this character is described as " p-type."

The n-p Junction

As an introduction to the sort of effects to be expected, let us imagine a region of p-type material in contact with one of n-type. This can be produced in various ways, for example, by varying the growth-rate of germanium crystals from a melt containing both donor and acceptor impurities which segregate at different rates[5] *, by applying impurity elements to the surface of a germanium crystal by electrodeposition and subsequent heating so that the impurity diffuses into the germanium,[1] by passing a heavy forming current of the order of ampères via a whisker through a tiny fragment of an acceptor or donor element on the surface of a crystal of silicon,[6] or even by pressure-welding a solid block of p-type germanium to another of n-type whilst maintained just below the melting point.[7]

The distribution of donors, excess electrons, acceptors and positive holes is shown in Fig. 7a; the potential energy of an electron is plotted against distance along the specimen in Fig. 7b. (This is, in fact, the electrostatic potential, plotted on an inverted scale.) There is a " potential hill " between n- and p-type material. This must exist, for if it did not holes would diffuse into the n-type material, and electrons into the p-type. Both these processes would lead to an increase of negative charge in the p-region, i.e., to the plateau shown. These diffusion currents continue to exist, some of the electrons diffusing up the hill into the p-type region, where they may diffuse back to the hill and down it, or combine with a hole. Electron-hole pairs are generated in the p-type material, of which the electrons diffuse to the hill and down it, so that in the absence of an externally applied potential the two currents balance. A similar process occurs for the holes.

If a potential is applied so as to increase the height of the hill, virtually no electrons diffuse up it, and the electron current is unaffected by the value of the bias applied. The junction is said to be saturated. The current of electrons thermally generated in the p-type region continues to flow, and there is thus a small net current in the direction of the applied bias. Conversely, a bias decreasing the height of the hill leads to a rapid increase in the electrons diffusing up the hill until the height of the hill approaches zero, when the charge density of minority carriers (i.e., holes in n-type material and vice versa) affects the density of majority carriers and a different set of conditions arises. As in the case of zero bias, the holes behave in an analogous manner.

The reader will have recognized the above description as that of a rectifier. Junction rectifiers have been constructed using acceptor and donor electrodes fused on to a silicon or germanium crystal. Reverse currents as low as 10^{-3} A and rectification ratios of 10^{8} : 1 at ambient, 10^{4} : 1 at 200 deg C have been obtained from silicon junction diodes, whilst germanium junction diodes have been produced with a back voltage of 600 V, a power output of 100 W and a good rectification ratio up to 100 kc/s. The characteristics of these devices are markedly superior to those of vacuum tubes, mercury vapour and selenium rectifiers.

The n-p-n Junction Transistor

We shall now consider, in the light of the mechanisms outlined above, the simple junction transistor. Fig. 8a shows the layout: a single crystal of germanium consists of three regions, to which are attached metallic contacts of low resistance which do not inject minority carriers into the semi-conductor. Fig. 8b shows the potential hill in the absence of applied biases: the majority carriers are

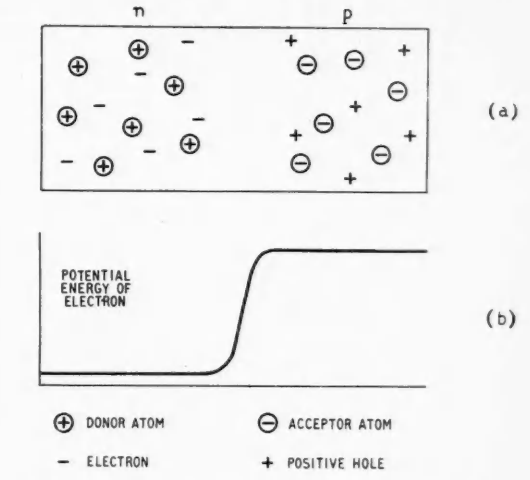


Fig. 7.—A p-n junction in germanium: (a) diagrammatic representation of distribution of charges; (b) energy diagram

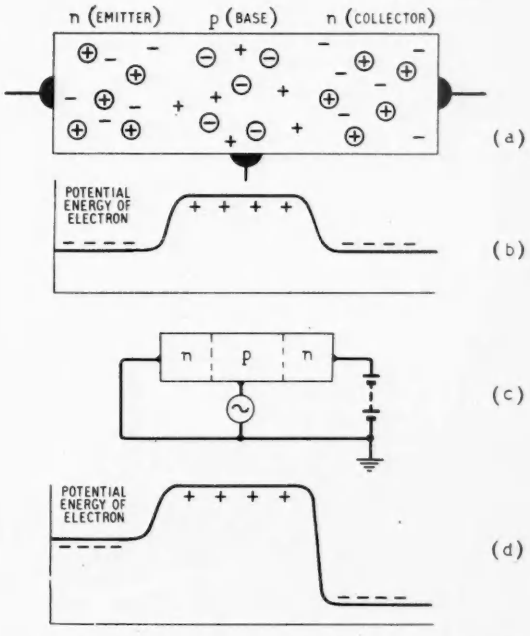


Fig. 8.—An n-p-n junction transistor: (a) distribution of charges; (b) energy diagram; (c) grounded-emitter circuit; (d) energy diagram of biased transistor

* A similar technique is used to obtain semi-conducting materials in a condition of highest purity: the impurities are concentrated in one end of the ingot, which is cut off and discarded.

indicated, the electrons being at the foot of the hill, whilst for the holes the scale is inverse.

Fig. 8c shows the basic grounded-emitter circuit. The positive potential applied to the collector biases the collector-base junction in the reverse direction, the potential hill now assuming the form of Fig. 8d in the case of zero signal. The current flowing across the collector-base junction is not, however, simply that of the reverse-biased p-n junction of the previous section. Any electrons diffusing up the emitter-base potential hill and then diffusing through the base without combining with a hole, will readily descend the base-collector hill and appear as collector current. If the base region is sufficiently thin combination will be negligible, and a positive-going signal applied to the base will reduce the emitter-base potential hill causing an increase in emitter current, virtually all of which will appear as an increase in collector current.

The base thus plays a part analogous to that of the grid of a vacuum triode. There is, however, an increase in the emitter-base current, mainly due to hole current from base to emitter. Current gains (i.e., ratio of collector current increase to base current increase) up to 100 are obtained.

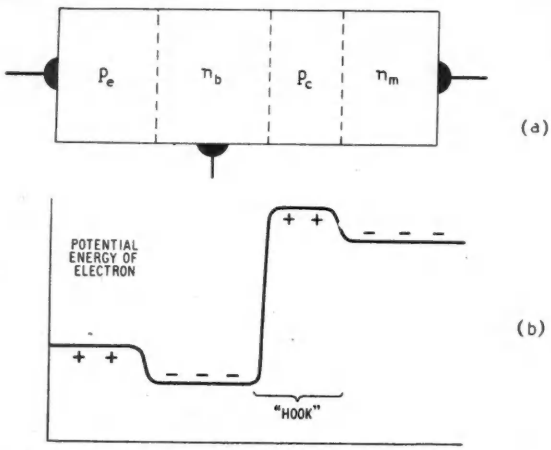


Fig. 9.—A p-n hook transistor: (a) distribution of charges; (b) energy diagram of biased transistor

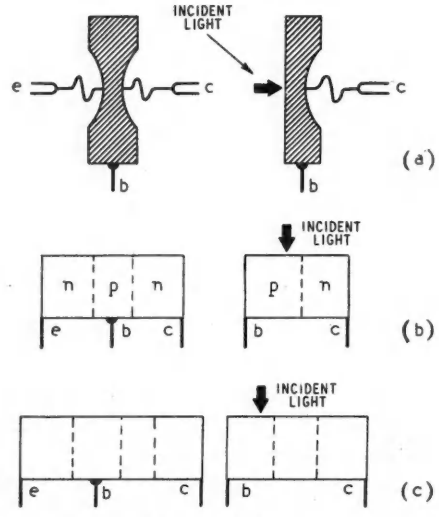


Fig. 10.—Photo-transistors with (left) the prototype transistor structure: (a) point-contact type; (b) junction type; (c) p-n hook junction type

The output impedance is very high (of the order of megohms) because the collector-base junction is saturated, whilst the effect of base potential upon electron current is very great; thus a power gain of 50 db is obtained. Unfortunately, the capacity of the p-n junction is comparatively large, and the high-frequency performance of junction transistors is noticeably inferior to that of the point-contact type.

Junction transistors on the home market, operating on 4 V collector-emitter, give current gains of 17–30. The output impedance, operated with grounded base, is rather less than a megohm.

The p-n Hook and the p-n-p-n Transistor

A configuration of some interest is the "p-n hook." In Fig. 9a n_m is a "multiplying region" of n-type material, whilst p_c is a p-type region thin enough for electrons to diffuse through without re-combination. The emitter current consists of holes, which flow through the n-type region n_b into the region p_c. Here they are retained by the potential "hook" (the potential energy of a hole being, of course, in the inverse sense to that of an electron) and a space charge builds up. If the region n_m is more strongly n-type than p_c is p-type, the current between them will consist largely of electrons, which readily diffuse through p_c and down the potential hill between p_c and n_b, and will be strongly affected by the space charge in p_c.

Thus a small increase in emitter-collector current results in a large increase in collector-base current, the junction p_c–n_m acting as a multiplying junction. Collector contacts which appear to be of this type have been produced, and a photo-transistor derived from them is described below and in Fig. 10c.

The Point-Contact Transistor

Paradoxically, the theory of the point-contact transistor is less well understood, although it was the first and perhaps remains the most highly developed. It is necessary to "form" the collector by passing a current of the order of an ampère for about a second, and it has been established[8, 9] that a small region of high-resistivity p-type material is formed under the whisker, whilst the bulk of the germanium is, of course, n-type. Valdes[9] has suggested that a further n-type region exists immediately under the collector point, and that transistor action occurs through the "hook" mechanism. It has been suggested, however, that the transistor action occurs by means of "traps," crystal imperfections in the region under the whisker which retain positive holes for some time before releasing them, thus increasing the positive space charge in this region and increasing the electron flow from the metal collector into the bulk germanium.[10] This view is, in fact, better supported by experiment.

Besides the Type A transistor, another pattern has been developed, consisting of a thin wafer of germanium, dimpled on both sides in the middle, and with whiskers on both sides of the thin central position, as sketched in Fig. 10a.

Germanium Photo-Transistors

Three types of photo-transistors have been described[11] and are shown in Fig. 10, together with their respective prototype transistor configuration. The point-contact form is enclosed in a small metal cylinder open at one end; the others are enclosed in small blocks of transparent plastic, painted black except for a window area. In the transistor minority carriers (i.e., holes in n-type material and vice versa) are injected from an emitter; in the photo-transistor they are produced by the disruption of the co-valent bonds in the lattice by incident light energy.

The photo-transistor biasing is, naturally, that of a transistor with emitter omitted. A small "dark current" flows, appropriate to the reverse-biased collector junction, which increases when illuminated. To be effective, the light must be incident within a fraction of a millimetre of the point contact or junction. With suitable masking, the lag due to the finite transit time of the electrons to the junction can be reduced to 1–2 μsec, thus making it possible to amplify electronically a signal derived from a light beam "chopped" at frequencies up to a megacycle. Sensitivities range from 0·1 mA/m lumen and 0·03 mA/m lumen for the point-contact and p-n types to 100 mA/m lumen for the n-p-n type photo-transistor.

Circuit Applications

As the space available for equipment and the weight and power drain permissible are decreased, the attractiveness of transistors increases. Thus a 130 c/s fixed-frequency oscillator has been described, driven by a 6 V battery with a 35 mW power drain, with an output of 8·5 V r.m.s., and a frequency drift of $\pm$ 7 per cent throughout life. Control applications suggested include replacing magnetic amplifiers, amplidynes and thyratrons. A main transistor controlled by auxiliary transistors behaves in a way resembling the phase-controlled rectifier, and circuits have been devised for the control of d.c. and induction motors. An r.f. power pack has been built to replace an already miniaturized battery, with a further saving in weight and space.

Certain limitations reduce the applications, thus the "hole storage effect" (actually a more complex phenomenon) gives rise to a form of cross talk, and the usefulness generally drops at higher frequencies. However, point-contact transistors constructed of low resistivity germanium, and with very small whisker spacing have oscillated up to 30 Mc/s, and in one case at 300 Mc/s. The noise was another great drawback of early forms: current point-contact devices, however, have a noise factor of 50 db, and the junction type, 15 db.

A logical next step is to combine transistors with printed circuits. Their reliability is already such that they can be wired in permanently as a long-life component. In airborne equipments, savings of 20 per cent in size, 25 per cent in weight and 40 per cent in failure rate have been achieved in this way. They can be used in a wide variety of circuits: thus in certain circuit conditions, negative resistance characteristics may be exhibited. An astable multivibrator has a very simple circuit, and repetition rates of 200–10,000 c/s are possible. Other circuits embodying transistors, usually in conjunction with printed circuits, include trigger and switching circuits, binary counters, a position encoder and digit register, and a regenerative amplifier.

Among the latest developments is a transistor hearing aid which is now in quantity production in the United States. A car radio has also been built with experimental tubes cutting the current consumption from 6 A to 0·6 A. Another is a personal transistor receiver largely using standard available transistors; when compared with a thermionic valve operated receiver it has double the output, half the size, two-thirds of the weight, one-tenth of the d.c. power requirement and a battery life of five times.

REFERENCES

[1] Much of the material in this article is based upon the "Transistor Issue" (November, 1952) of the *Proc. I.R.E.*, and W. Shockley's "Electrons and Holes in Semi-conductors." (D. van Nostrand Company, 1950.) In particular, Figs. 4, 6 and 8 are based on Figs. 3, 12, 21 and 22 of W. Shockley's paper (p. 1289), and Fig. 2 upon Fig. 11 of J. A. Morton's paper (p. 1314).

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Liverpool E.C.A. Dinner

THE annual dinner of the Liverpool branch of the Electrical Contractors' Association was held in Liverpool on 22nd March. Mr. T. K. Richardson, who presided, welcomed representatives of other E.C.A. branches in the area, chief officers of the Area Electricity Board and representatives of other professional organizations.

Proposing the toast of the E.C.A., Mr. D. H. Kendon, the new chairman of the Merseyside and North Wales Electricity Board, said that he did not think that his Board would give up contracting, but that did not mean there need be any antagonism with the electrical contractors. The Board would play fair on the basis of friendly rivalry. Electricity was now in plentiful supply and the industry was no longer handicapped and handcuffed.

Mr. C. C. Penwill referred to the "gentlemen's agreement" made between the B.E.A. and the E.C.A. Electrical contractors were the unpaid canvassers of the electricity supply industry, and consequently it appeared to him manifestly unfair for the Boards to compete with them. It was now well known that by co-operation between the B.E.A. and the I.E.E. a new code of wiring regulations would be issued. With the responsibility that would fall on the Boards it was hardly necessary for them to compete in the electrical contracting field, and thus be judges in matters affecting their own interests.

He believed we were faced with the need for the complete rationalization of the trading structure of the electrical industry. Manufacturers and wholesalers who supplied the trade were in active competition with the electrical contractor and retailer. Competition should not take the place of co-operation.

The time had come to review the complete approach to the wage structure of the industry. Claims were being advanced for more wages on the basis of cost of living. The cost of living was something common to all operatives. That being so, was there not justification for the suggestion that disputes should not be settled industry by industry, but by a national committee which would have in mind the economics of the country?

Mr. W. T. Trace proposed the toast of the guests, for whom the Lord Mayor of Liverpool (Ald. W. J. Tristram) replied.

The Transatlantic Telephone Cable

Further Constructional Details

IN the *Electrical Review* of 4th and 11th December, 1953, we announced the agreement which had been signed by the American Telephone & Telegraph Company, the British Post Office and the Canadian Overseas Telecommunication Corporation for the provision of a submarine telephone cable system across the Atlantic, and gave some design particulars of the system so far as they were then known or anticipated. The system will be owned jointly by the three administrations, and the project will take three years to complete at a cost of £12½ million. The British contribution will be the production of a major part of the cable and of the submerged repeaters between Newfoundland and Nova Scotia, and the laying of the submarine cables by H.M.T.S. *Monarch*. The remainder of the cable, and the submerged repeaters for the main crossing, will be produced in the United States.

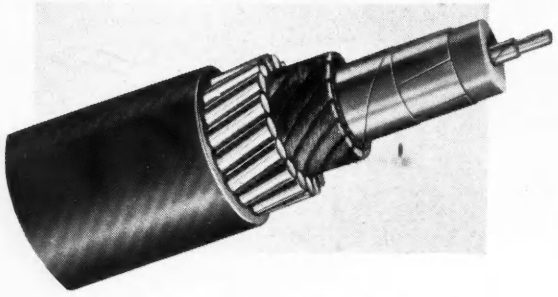
Submarine Cables, Ltd., jointly owned by Siemens Brothers & Co., Ltd., and the Telegraph Construction & Maintenance Co., Ltd., is equipped to undertake the manufacture of such a cable at its works at Greenwich and Erith, and an initial order for the manufacture of nearly 90 per cent of the first of the two telephone cables to be laid between Oban and Newfoundland has been placed by the Post Office with this company.

The new system will in time supplant the existing transatlantic radio-telephone circuits, and will provide greater reliability for 36 simultaneous conversations. It is proposed to allocate 29 circuits for traffic between New York and London, and six circuits between Montreal and London. From the terminal cities the circuits will connect with the telephone systems of the respective countries; in addition it will be possible to extend circuits from London to continental Europe via existing telephone facilities.

Submerged Repeaters

The two cables across the Atlantic will be ten times longer than any other cable so far used for submarine telephony, and the first cable will be laid in depths exceeding 1,000 fathoms. Such a project is made possible by the development of submerged repeaters, i.e., electronic amplifiers in watertight and pressure-resisting casings to be laid with the cable and to rest on the sea bed, retransmitting the telephone frequencies at greatly increased strength.

With carrier frequency operation, a band of 144 kc/s will be occupied by the 36 speech channels. For the main crossing of 1,950 nautical miles from Scotland to Newfoundland, the submerged repeaters will be of the type developed by the Bell Telephone Laboratories and installed in the Key West-Havana cables in 1950. They are designed so as to be included under the cable armour, forming a bulge about 3 inches in diameter, tapering off at each end to the cable diameter, the length of the "housing" being about 20ft. The bulge is sufficiently flexible to pass through the gear of a cable ship, so that laying and recovery in 2,500 fathoms will be facilitated. Only one-way transmission is provided, which necessitates two cables each transmitting the frequency band from 12 to 156 kc/s. Spaced at intervals of 37 nautical miles, over 50 repeaters will be laid in each cable, and each repeater will have three valves.



Type B submarine telephone cable for intermediate depths

For the 310 n.m. stretch from Newfoundland to Nova Scotia in a depth of 250 fathoms, "lump" type repeaters developed by British engineers will be used. So far nineteen submerged repeaters of this type have been installed in cables in European coastal waters, and another seven, modified as required for the new project, are to be included in the Aberdeen-Bergen cable now being manufactured at Greenwich. With the greater space available, filters permitting two-way working can be accommodated, so that one cable suffices, transmitting two frequency bands which provide separately for the speech channels in the two directions. Repeater spacing will be less than for the main crossing owing to the greater attenuation at the higher operating frequency. From Nova Scotia a microwave radio-relay link will connect for 350 miles overland to the United States.

Insulation and Construction

The cables will be of the single coaxial type already well tried out in shallow water. They will be insulated with polythene, mixed with 5 per cent of polyisobutylene or butyl rubber, and a small amount of antioxidant to prevent slight deterioration of qualities during processing. Polythene, a synthetic thermoplastic hydrocarbon with a dielectric constant of 2·3, a power factor of 0·0003 and very high resistivity, was discovered by Imperial Chemical Industries in 1933 during high pressure investigations. Only minute amounts were produced at first, but by 1937 a small quantity became available for experiment.

An important factor in the processing of polythene is its melt viscosity. It is measured by the extrusion rate from a standard plastometer, called a "grader," at specified temperature and pressure. In the present case a hard polymer will be used, extruded on to the inner copper conductor which has a composite structure of a 0·131in wire surrounded by three tapes 0·0145in thick. The diameter of the insulator will be 0·620in. Surrounding the insulator is the outer conductor, consisting of a layer of six copper tapes applied with a long lay, and held in position by a copper binder tape and a protective tape applied with short lay. The jute serving, galvanized steel armour wires, and outer serving depend on the depth and sea-bed conditions in the locality of laying. For deep sea cable an armour of 24 wires of 0·086in diameter will be used, each wire being protected by a coating of compound and an impregnated fabric tape. The overall diameter is 1·2in, and the weight is 62 cwt/n.m. in air or 36 cwt/n.m. in water.

For intermediate depths the cable has eighteen No. 8

wires, and in this case the overall diameter is 1·4in, the weight of the cable being 112 cwt/n.m. in air or 80 cwt/n.m. in water.

For shallow water still heavier armour will be used, and possibly double armour for short approach where a rocky sea bed may be encountered.

Numerous technical problems needed solution to ensure the success of the project. Submerged repeaters had to be developed which could be successfully laid, and would operate without attention over long periods under hydrostatic pressures of 3 tons/in. Conditions for long life of thermionic valves had been investigated for years. Power to operate the repeaters will be supplied by a direct current through the inner conductor fed from the ends of the cable; for the long crossing 2,000 V positive will be applied at one end and 2,000 V negative at the other end. Finally, methods of locating faults and effecting repairs had to be worked out.

Earth Return Distribution System

IN the sixteenth (1953) report of the State Electricity Commission of Queensland, Australia, it is recorded that the two trial installations of the single wire earth return system which were installed by the Cairns Regional Electricity Board on the Atherton Tableland have given satisfactory service. The main purpose of the system is to reduce the cost of extending electricity into areas where three-phase or standard single-phase systems would be too costly. It is believed that this area was the first in the Commonwealth to be given a supply from an earth return system, and the Board may well be proud of its contribution to development work which will enable electricity to be extended into sparsely populated areas where the possibility of closer settlement and high load density are unlikely for many years.

Interesting features of this earth return system, which has been based on that of the originator, Mr. Lloyd Mandeno, of New Zealand, are given. The two trial installations are at Atherton and Malanda, and each has its own isolating transformer and supplies 20 and 12 farms, respectively. Each installation can be expanded to cover 30–40 farms from the existing isolating transformer. The operating conditions permitted by the P.M.G.'s Department are similar to those operating in New Zealand for the protection of telephone circuits.

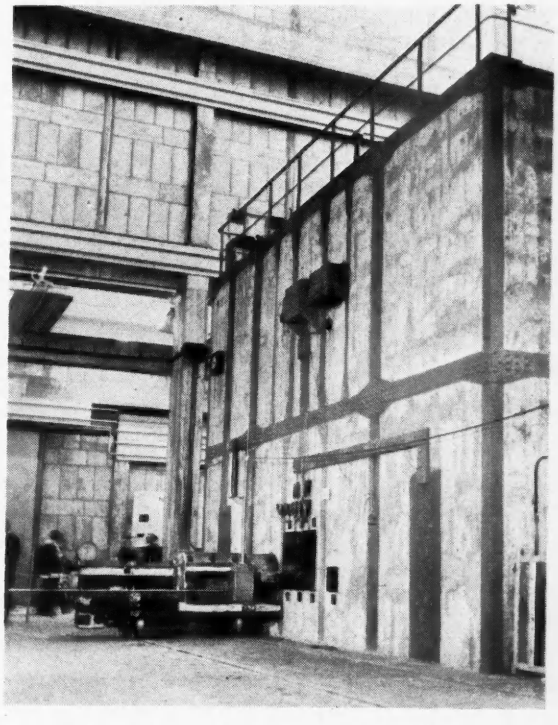
The major limitations are: (1) The single wire line running parallel to communication lines must have a minimum separation of four chains; (2) the earth return current is limited to 8A; and (3) there must be no interference with telephone circuits.

The single wire voltage is 12,700, i.e., the phase-to-neutral voltage of the Board's 22 kV system. In the main three strands of No. 12 galv. 90 ton quality steel are used with average spans of 1,020ft; the longest individual span is 1,940ft. At each pin insulator support an armour rod damper is installed. The single-phase isolating transformers are 50 kVA 22,000/415/240 V fully insulated units and the single-phase distribution transformers are 5 or 10 kVA 12,700/480/240 V with graded insulation on the h.v. winding. The maximum earth resistance value stipulated by the P.M.G.'s Department is 5 ohms, although in New Zealand practice the value is 2·5 ohms. This ohmic value is achieved by driving ¾in diameter steel rods 18–20ft in length and spaced 35ft apart. The P.M.G.'s Department has carried out tests on these installations to determine interference values, and the results of this work will assist in the formulation of the Department's Regulations which will govern the erection of single wire earth return rural systems throughout the Commonwealth.

As a result of experience at Cairns the Commission has approved the single wire system and is of the opinion that it has special merit for the extension of electricity in rural areas to farm homesteads which are widely separated, thus enabling a supply to be given under such circumstances to meet normal farm requirements at reasonable cost. The success of the trial installation in the Cairns Region is of interest not only in Queensland but also in other States. Nevertheless the application of this system must be approached with every caution, as it will cater only for special areas where the demand for electricity is relatively limited and with little prospect of development.

Atomic Energy Development in France

THE accompanying illustration is of the second atomic energy pile which has been built in the French nuclear energy study centre at Saclay. It contains uranium 135 covered by an aluminium protective envelope. A stream of compressed nitrogen flows over the bars during washing in an aluminium basin of heavy water. The basin is protected by a graphite sheath 3ft deep and by a 1ft thick cast steel ring. The Saclay establishment is a research centre rather like Harwell in this country.



The second atomic energy pile at Saclay, France

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Machine Driving Methods

IN the editorial in your issue of 19th March you say it is a pity that some engineers still refer to the Ilgner set as a Ward-Leonard control driving unit embracing a flywheel. The engineers who do so at least have the support of the British Standard Glossary of Terms used in Electrical Engineering, since definition No. 2313 (British Standard 205: Part 2: 1943) reads as follows:—

> "2313 Ilgner system.—A system in which a Ward-Leonard generator and its driving motor are coupled to a flywheel capable of storing considerable kinetic energy, the variations of which compensate to a large extent for the variations of load on the rotor supplied by the generator, and therefore reduce the maximum power demand from the supply system."

Although the Glossary may not be accepted as an infallible authority, I would suggest that definition No. 2313 is correct.

Wolverhampton. H. NEWCOMBE.

UNDER the heading "Machine Driving Methods" your editorial in the current issue deprecates the use of the term "Ilgner set" in a sense which you suggest that it either does not, or ought not to, bear. May I remind you that in using this term in the sense to which you object engineers have the presumably unimpeachable authority of B.S. 205.

While it may well be that from the historical point of view your opinion is justified, it would nevertheless appear that your effort at reform is rather too late and should in any case be directed at the British Standards Institution.

A.M.I.E.E.

[The only thing we deprecate is the confusion which exists in some quarters in the respective uses of the Ilgner set and Ward-Leonard control. We constantly see in all parts of the country Ilgner flywheel sets without Ward-Leonard control. A better heading to the B.S. definition 2313 might be "Ilgner–Ward-Leonard system."—Editors, *Electrical Review*.]

Nuclear Power Prospects

ACCORDING to the *Electrical Review* of 12th March Sir John Cockcroft, director, Atomic Energy Research Establishment, Harwell, was reported to have told the Parliamentary and Scientific Committee of the House of Commons that to meet the expected deficiency of 20 million tons of coal a year by 1965 atomic energy plants of a total of 5,000 MW would be required, and that these plants could be made available between 1965 and 1970.

From the latest Ministry of Fuel and Power Statistical Digest, it can be seen that during 1952 the total average installed capacity of generating plant was 17,077 MW (Table 72) and that during the same period the total amount of coal consumed by these generating plants was 34,462,000 tons. It is clear therefore that the 5,000 MW of atomic energy operated power stations would save slightly more than 10 million tons of coal per annum.

Another point of interest is that the Ridley Committee reported that the coal shortage by 1960 would be 30 million tons per annum on the assumption that we would import oil to the equivalent of 14 million tons of coal and depend on the further development of hydro-electric power for producing the equivalent of a further million tons of coal. It would be extremely unwise to import oil to replace coal, on account of its high cost, and to make the necessary alterations to industrial plants which would become redundant later. The annual coal shortage by 1960 on this basis is therefore likely to be 45 million tons. It would be safer to take the estimate of the Federation of British Industries of 50 million tons per annum. These estimates include about 30 million tons for annual coal exports. The remaining 20 million tons per annum would be necessary to meet industrial and domestic requirements, and is the expected deficiency referred to by Sir John Cockcroft, which makes no provision for coal exports.

While everyone must be glad to know that we shall have atomic energy in about 12 years' time, and though even the 5,000 MW will be a great help, it is not nearly enough as it will save only about 10 million tons of coal per annum. As we shall begin to suffer from a severe coal crisis in from four to six years' time we must make a tremendous effort to save as much coal as possible during the next few years, by cutting down the colossal waste of coal at present taking place.

To meet the coal shortage we should make plans now for the importation of electricity from the European electricity grid. According to the recent Electricity Supply Supplement of *The Times*, 40 per cent of the electricity used on the Continent is from hydro-electric power. In Austria and Jugoslavia water power sufficient to produce a total of over 80,000 million kWh is still available to be harnessed. It should be possible for this country to make arrangements for the harnessing and supply of 20 to 30,000 million kWh per annum, which would assist this country for some years until we can have sufficient atomic energy operated plants to meet Britain's industrial and domestic requirements. This would be more desirable and more practical than importing coal at £9 or £10 per ton from America. The idea of importing oil should be cancelled. Above all, immediate action is necessary because we are heading for a very grave industrial crisis.

W. WAKEFIELD ADAM, M.I.Mech.E., M.Inst.F.

Twickenham, Middlesex.

Railway Electrification and Load Factor

I READ with much interest in the *Daily Telegraph* of 25th March Mr. Nabarro's letter advocating the electrification of the railways to save exportable coal, to assist in smoke abatement, to improve public health and, what in my view is most important, to improve the load factor on the B.E.A.'s power stations, which burn otherwise unusable coal.

When I recall Mr. Nabarro's past condemnation of the use of electricity, especially for domestic use, it is very gratifying to note that he now sees the urgent need to improve this load factor by all means, of which the extensive use of electricity for domestic purposes would assist.

London, W.3. N. E. WHITTLE, M.I.E.E.

Spain to Make Argon

An industrial group from Bilbao is proposing to establish a new factory in Madrid for the production of argon gas for use in the manufacture of electric lamps, etc. Total output will be in the neighbourhood of 15,000 cu metres per annum.

Power for Aluminium Production

The Kemano-Kitimat Scheme

THE Supply Section paper on "The Kemano Hydro-Electric Development and Associated Kitimat Aluminium-Reduction Works," by Mr. F. W. Lawton, read before the Institution of Electrical Engineers on 25th March, formed the basis of the article on this subject in our last week's issue.

Mr. J. Eccles (B.E.A.), who opened the discussion, commented on the use of generators with two equal windings and of transformers having two primary windings. He said that a station in Sweden having these features had been put into operation some time ago, but he understood that in a later station the generator and transformer were connected as one unit without circuit breakers on the 13·2 kV side, switching being done at 300 kV.

At the generation end of the Kemano-Kitimat scheme the protection seemed elaborate, and there was quite a battery of switchgear at Kitimat, but the intermediate transmission lines were, in contrast, protected solely by overload and earth leakage relays.

Mr. H. J. Cochrane (Sir Wm. Halcrow & Partners), speaking as a civil engineer, referred to vagaries of Government policy on investment in the Commonwealth. The oilfields and ore fields of Canada seemed to be falling almost entirely under United States financial control, and the London money market might be suspected of not being able to cope with finance of the magnitude sometimes required. He understood, however, that the British Government had invested considerably in the Kemano-Kitimat scheme. There seemed to be standard components for the generating station, water-wheels, generators, and many other major items being all different.

Mr. C. Paton (Northern Aluminium Co.) pointed out that the United Kingdom, which smelted only some 35,000 tons a year, was dependent on Canada for 85 per cent of the aluminium used here. Altogether it imported 200,000 tons a year and took half of Canada's output. World consumption of aluminium seemed to double itself every ten years. At the moment there was a production deficit of about 166,000 tons per annum in this country, and by 1960 it would approach 350,000 tons.

Mr. D. E. Bird (Ewbank & Partners) asked why the Kemano station had been put underground. The h.v. cables were probably the first installation of any real magnitude of aluminium conductor cable in an aluminium sheath, and he asked what jointing system was being adopted.

Unusual Features

Mr. E. T. Norris (Ferranti) commented on some unusual features—a 300 kV transmission line only 50 miles long, which was an indication of the enormous scale of the operation; a single-circuit transmission line which in certain conditions would carry a million kilowatts; a generator chamber hewn out of the middle of a mountain, and larger than the nave of St. Paul's; and the reversal of the flow of a river so that it turned round and reached the sea in eighty miles instead of five hundred.

In the last two years, he said, he had been concerned with three large orders for generator transformers of 200-300 kV for North America, and had been pleased to find the purely functional approach adopted. When there was fierce international competition a manufacturer was very vulnerable to technical pressure from the customer, but there had been no sign of that in the three cases to which he referred. Of the transformers of which details were given in the paper, B in Table 3 and C in Table 7 came from the United Kingdom, and every unit was surge-tested at 1,050 kV full wave and 1,210 kV chopped wave. The design was such that a transformer weighing over 100 tons could be replaced in three hours, a feat that was achieved by the expenditure of thought rather than money. He inquired whether the fitting of lightning arrestors or rod gaps was proposed.

Mr. P. Robinson (Kennedy & Donkin) said that the number of lines was a restrictive feature, the voltage having to be raised to transmit the required amount of power. It was unfortunate that there was no more room for the lines, because in the transmission there was almost 100 per cent standby. He assumed the power factor of the load to be about 0·93.

Mr. F. W. Gee, referring to the ability to change the transformers quickly, said that in addition to their being very heavy they were by different manufacturers, one Canadian and one British. Any transformer had to be able to take the place of any other, so that a good deal of co-operation had been necessary at a range of 4,000 miles. That co-operation, owing to the spirit shown by the customer and the Canadian manufacturers, had been very easy.

Tower Construction

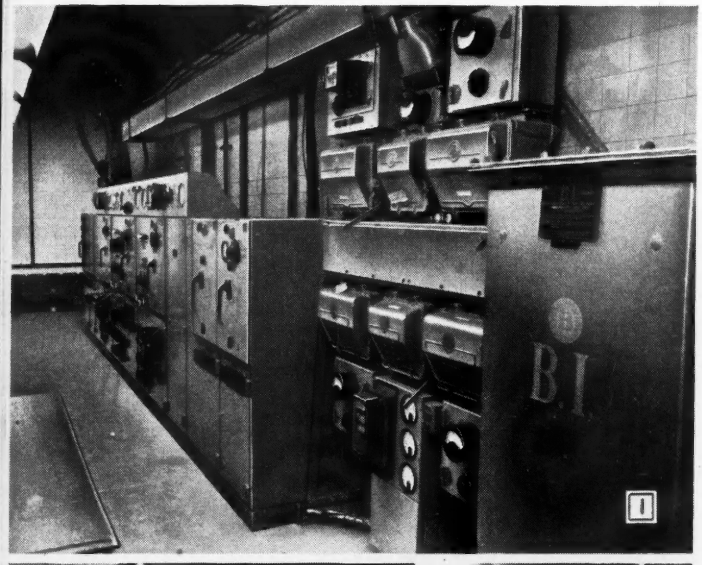
Dr. K. Sutter (Aluminium Laboratories) said that the aluminium towers consisted of an inverted V on one side and a tripod on the other, and over these two structural elements was placed the cross-arm, having a length of about 70ft and a cross-section of 2ft × 4ft. A diameter of 38in had been chosen for the legs as being suitable in most cases; in some instances they would have liked to go to 40in, but they had to take into account the manufacturing limits of the aluminium sheet, since they wanted to have only two longitudinal seams in the legs, and this imposed a limit of 38in. The maximum span was about 2,700ft, and the minimum 700ft.

The author, in reply, said that while complete protection was necessary for the generators and transformers it was believed that very little could happen to the line. It was ruggedly built, and in their experience the simplest form of protection was desirable. Lightning arrestors and rod gaps were not fitted; from experience in severe lightning country he believed they were a snare and a delusion.

The reason for the different types of water-wheels, generators and transformers was that they were to some extent "reaching out into the blue" and wanted to gain experience, so that the best types could be used for the additional units. The reasons for the generating station being underground were primarily economic. The glacial deposits of the Kemano valley would provide unsatisfactory foundations; the slope over which conventional penstocks would have to run was such that there would be risk of slides, and the pressures at the base of the penstocks would have meant using very thick steel.

Dr. L. G. Brazier referred to the statement in an American report that between 1950 and 1975 the American consumption of primary aluminium would increase four-fold, and that the reduction of this metal would require 65,000 million kWh a year, or more than the total consumption in Britain at the present time.

STORES



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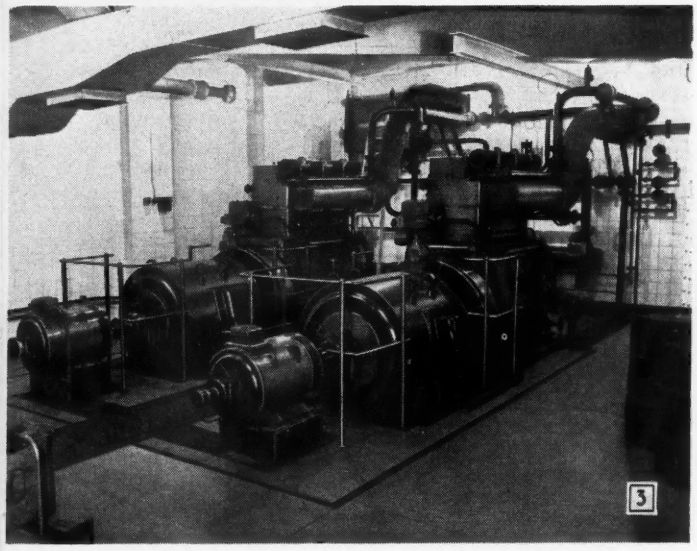

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IN 1941 bombing completely destroyed about half of Lewis's stores at Liverpool and severely damaged the remainder. In the reconstruction now in hand less than a quarter of the original premises is being retained and the remainder is being completely rebuilt, involving the provision of an entirely new electrical installation. The scheme has now proceeded sufficiently for us to obtain a good idea of the final arrangements: the main substation has been completed, as well as the local transformer rooms and switchrooms, and it is also possible to see the heating and ventilating plant and typical lighting schemes.

The electricity supply for the nine-storey building (including basement and sub-basement) is at present received at the Merseyside and North Wales Electricity Board's substation in the sub-basement at 6 kV but the switchgear is designed for eventual 11 kV operation. The two incoming feeders are carried to two Reyrolle 400 A, 250 MVA switches with a bus-coupler between. At the side of these switches are identical units belonging to Lewis's and controlling the supplies to each end of a twelve-panel English Electric h.v. switchboard.

This board comprises two 400 A, 250 MVA circuit breakers with isolators for the incoming supply, a bus-coupler and three 400 A, 250 MVA panels on each side for outgoing circuits. One of these panels feeds an adjacent 1,000 kVA, 6 kV/400/230 V English Electric transformer which provides the power supplies and also the emergency lighting. Two more panels supply two 600 kVA transformers connected to two sets of 2in diameter (walls approximately $\frac{1}{4}$in) tubular copper busbars (Power Centre) carried vertically through the building for the departmental lighting and power. The busbars, which are designed to carry 1,000 A per phase, have small holes at the bottom to admit air for cooling purposes. A fourth panel serves two 300 kVA English Electric transformers, connected in parallel, at roof level (for kitchens and restaurants), while a fifth panel controls two similar units on the sixth floor (for the lifts), the two sets of transformers being interconnected so that should either set fail the other can temporarily carry part of the load. One spare panel is available for extensions.

Stand-by Electricity Supply

The 1,000 kVA transformer is connected by parallel feeders to an English Electric medium voltage board to which is also taken the supply from two 110 kVA diesel alternator sets, a bus-coupler enabling either or both machines to feed either end of the board. To prevent possible overloading the diesel sets are fitted with under-voltage relays which are set to operate within 25 seconds. Emergency circuits are taken to a separate 300 A panel on the switchboard and arrangements have been made in the event of an emergency to give a supply to the transformer switchroom on the sixth floor to enable a lift to be operated. Provision is also made for an emergency supply to be taken to the various refrigerators throughout the store.

Switchrooms for the lighting and power circuits are provided on every floor up to and including the fifth. The supplies for the lighting are fed through 150 A switch-fuses to Power Centre boards incorporating "Mutac" micro-gap lighting switches. M.E.M. 30 A switch-fuses control the power supplies to Wandsworth 10 A socket outlets at

(1) L.v. switchboard and power factor correction capacitor;
(2) Lewis's h.v. switchboard; (3) Diesel generating sets

INSTALLATION

Electrical Equipment at Lewis's Liverpool Premises

the bases and tops of the pillars and also at positions in the ceilings midway between the pillars.

The two diesel sets comprise English Electric three cylinder engines direct coupled to 400 V alternators. Crypton starting apparatus is meshed to the flywheels to prevent running down the batteries in the event of the engines refusing to start. The starting circuit is automatically cut off immediately the engine fires. Should the level of the cooling water fall below a certain level an alarm is given.

Space heating and ventilation of the basement and sub-basement are carried out by means of a plenum system situated in the basement. A separate partial plenum system on the roof serves the kitchens and "Mersey Room" on the fifth and sixth floors, the remainder of the building from the ground to the fourth floors being warmed by unit heaters. The steam for the whole of the heating services is produced by oil fired boilers. The oil is preheated electrically by means of 24 V tracer type electric heating elements totalling 9 kW round the feed pipe and an electric pump is used to inject the oil into the combustion chamber when starting up. Condensate return and sump pumps are also provided. The induced draught fan is driven by 15 h.p. Crompton Parkinson motors equipped with Allen West starters. A Bradshaw fan with an 18 h.p. Brook motor draws air into the boiler room. The boiler house instruments were supplied by Bailey Meters & Controls, Ltd.

The calorifiers for the domestic hot water are heated both by steam from the boiler and also from the cooling water from the diesel engines. The water is circulated through the building by means of a 2 h.p. "Mopump." Two 3,000 gal/hr Sigmund pumps (7½ h.p. B.T.H. motors with Brookhirst controls) carry fresh water to storage tanks on the roof. An H. & L. compressor (5 h.p. Crompton Parkinson motor) ejects sewage to the main sewers.

In the basement plenum room the air is brought in from the street through a shaft by means of a 60,000 cu ft/min intake fan driven by a 50 h.p. Crompton Parkinson motor, controlled by a Brookhirst starter. It is then washed with the aid of a pump driven by a 12½ h.p. Hopkinson motor and passed through a steam heated battery. Air is extracted at a rate of 40,000 cu ft/min by a fan driven by a 27 h.p. motor. The contractors for the plenum plant were Ashwell & Nesbit, Ltd.

Restaurant Plenum Plant

The plenum plant for the restaurant ("Mersey Room") and servery, which has been installed on the roof by the Bradshaw Fan & Ventilating Co., does not provide for washing the air but only for filtering and warming. It incorporates an intake fan with a 25 h.p. Brook motor and E.A.C. starter. An extract fan for the kitchen and the restaurant is driven by a 70 h.p. motor. Also installed on the roof is a small pump for maintaining the pressure of the fire precaution sprinkler system, the main sprinkler pump, an 84 h.p. Mather & Platt unit, being situated in the basement.

The unit fan heaters (also installed by Ashwell & Nesbit, Ltd.) which serve the remainder of the building are thermostatically controlled, "Satchwell" motorized valves being used to control the steam supply through the heating coils. A considerable reduction in heat loss is secured by the installation of unit heaters over the entrances.

Striking lighting effects are to be seen all over the building. Cold cathode trough lighting ("Claudegen") has been employed for the main illumination in the "Mersey Room," the woodcut murals in which are specially lighted by G.E.C. fluorescent units. Supplementary lighting is provided in the "Mersey Room" by Courtney Pope tungsten fittings.

In the "Luncheonette" triple rows of "Atlas" red, white and blue hot cathode fluorescent tubes are concealed in a trough around a central lighting fixture housing tungsten lamps, some of which are on the emergency

The restaurant ("Mersey Room") at Lewis's reconstructed Liverpool stores showing the cornice lighting

lighting system. Merchant Adventurers ceiling fittings are employed in the corridor. The whole scheme harmonizes well with the modernistic setting which involves the decoration of the ceiling in dark red and the introduction of a wall motif representing forks and other feeding appliances. Courtney Pope fluorescent fittings are used in the staff canteen.

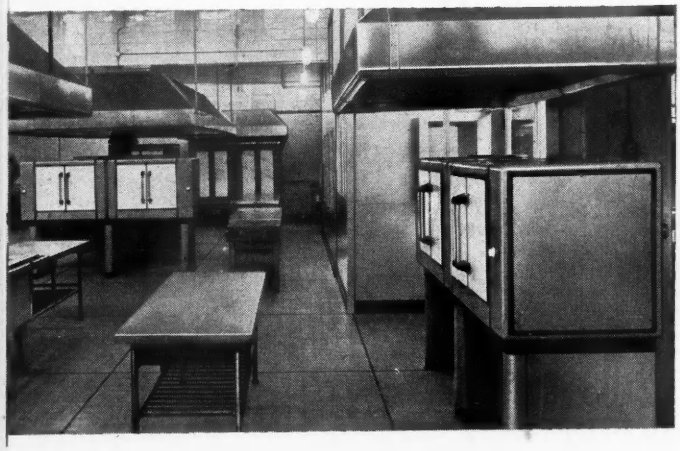
Another example of cold cathode lighting is to be found on the " Fashion Floor " (second) where white, ivory and gold have been selected for the cornices. Two " egg crate " fittings about 24ft by 6ft have been placed over the millinery section and the area near the escalators. Two 5ft and one 4ft fluorescent tubes light the fitting rooms, while 4ft tubes have been used to good effect in the showcases. Attention is drawn to items of special interest by means of G.E.C. and Fluorel spotlights. A combination of fluorescent and tungsten fittings has been used in some of the showcases in the basement. On the other sales floors considerable use is made of " Atlas " fluorescent fittings incorporating four 5ft 80 W warm white tubes. Wardle well glass fittings have been largely selected for the kitchen. Generally about sixteen Thorn four-tube angle fittings are used in the windows.

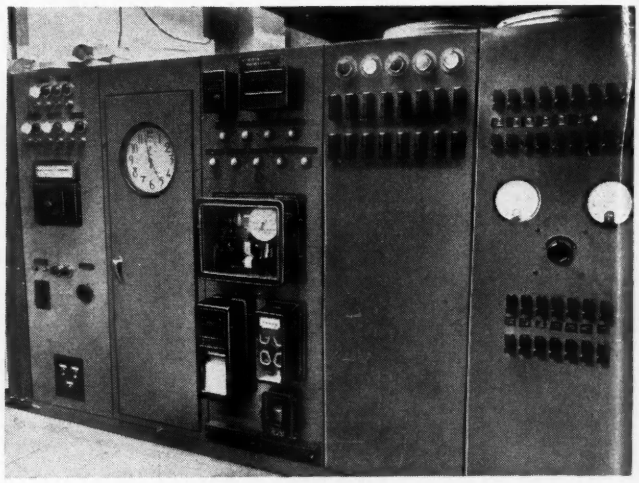
Kitchen Equipment

Food preparation, storage and serving equipment in the kitchen and servery, both of which are wired with Pyrotenax cable, includes four roasting ovens, three restaurant grillers and toasters, and six twin fish fryers (all Benham), Hobart mixers, Berkel slicers, a Peerless potato chipper, Minimax coffee sets, five Express service lifts, Frigidaire cold room, cold slabs and ice cream units, Still and " Hercules " dishwashers. In the " Luncheonette " to keep the dishes warm there are besides three hotcupboards (Gardner & Gulland) a cabinet of the same make incorporating a mixture of tungsten and infra-red lamps. A refrigerated water cooler (Non-Drip Measure Co.) is also provided. A further hotcupboard is installed in the managers' dining room.

Among other electrical features of the building are eight 24-passenger and two 25 cwt goods lifts (Express), ten escalators (J. & E. Hall), a signal light staff location and fire alarm system (Gent), a public address system (G.E.C.), a time recording system (International) and centre-tapped transformers (110 V to earth) for the use of appliances in the hairdressing department.

Central kitchen showing some of the electric ovens





Control board in the sub-basement

Supervision of the whole of the electrical and other services is carried out from a control room adjoining the substation. Apart from the metering equipment for the electricity supply comprising summation units, kVA demand indicators (Ferranti) and recording ammeters (Evershed & Vignoles) there is control apparatus covering the heating and ventilating system throughout the building. A Negretti & Zambra distance thermometer gives an indication of temperature at twenty-four different points in the building and there are variable speed controls for the plenum and extract fans with push-button and indicator lamps for the various motors. The heaters at the entrances are controlled separately from the other units. The master control for the clock system is also situated here.

The architects were G. de C. Fraser & Gearey. The engineering installation was carried out by Lewis's, Ltd., under the direction of the consulting engineer, Mr. Oscar C. Waygood, O.B.E., M.I.E.E., and the chief engineer, Mr. B. H. Lambert, Associate I.E.E., to all of whom due acknowledgment is made for help in the preparation of the article and for permission to publish it.

Heating by Solar Energy

An account of researches at the Imperial College of Science and Technology (University of London) into the possible application of solar energy to domestic water and space heating was given on 23rd March to the Institute of Fuel by Dr. H. Heywood. Indications are that solar space heating would be uneconomic in Great Britain owing to negligible radiation from the sun for long periods in winter. Elsewhere the only prospects of success would be within the latitude range of 20 to 40 deg where bright sunshine was more frequent during the winter and heating requirements were small, in which case daytime storage would be needed. Reduction in fuel costs would probably be almost offset by capital charges and the running costs of fans and pumps. Domestic hot water, however, could probably be made almost continuously available for rural areas in Britain from April to September, assuming sufficient absorbing area and storage to be used, as well as in the lower latitudes. Refrigeration and air cooling and heat pump combinations offered possibilities in tropical regions.

GENERATION AND DEVELOPMENT

Merger of B.E.A. Divisions

THE EXPERIMENTAL merging of the North Western and Merseyside & North Wales Divisions of the British Electricity Authority (from 1st April) was the subject of an " open letter " to his staff last week by Mr. A. R. Cooper, North Western Controller, who has taken over control of the new Division. In all about 8,200 workers are affected by the merger.

Mr. Cooper said that a good deal of anxiety had arisen among the existing staffs as a result of reports suggesting " wholesale dismissals," but no scheme had been evolved for dismissing anyone. It was possible that future developments might make it necessary for a few people to change their place of work and a very few might actually be redundant. If changes affecting individuals were proposed there would be the fullest discussion before they were made and there would certainly be no harsh treatment of the people concerned.

Mr. Cooper said that it had not yet been decided where the new headquarters would be situated, but he hinted that it might be in Manchester. If Manchester were chosen it would not follow that the Liverpool headquarters would be immediately disbanded; in fact it was reasonably safe to say that a Liverpool office would be functioning for some years to come.

Air Pollution in Westminster

Last week the Westminster City Council discussed the subject of air pollution from the Battersea and Fulham power stations. The Council was told that at first both stations were subject to strict regulations regarding the elimination of grit and smoke but in 1941 there was a relaxation since when the flue gases had been untreated. It was believed that the British Electricity Authority had told the Committee on Air Pollution that gas washing for the removal of sulphur dioxide was unnecessary.

A resolution was passed reminding the Committee on Air Pollution of the obligations imposed upon the electricity authorities to prevent sulphurous emissions from the stations and " assuming " that the Committee would not recommend any relaxation of the conditions without the support of independent scientists regarding the effects of sulphur emissions from power stations.

Large Scottish Contract

A contract valued at about £4 million has been placed by the North of Scotland Hydro-Electric Board with the Mitchell Construction Co. It covers the construction of two underground stations at Breadalbane, Perthshire, and seventeen miles of tunnels to link the stations with the Rivers Earn, Lednock and Almond. The company is already carrying out similar work at Glenmoriston. The scheme is to start this summer and will take four years to complete.

Power from Peat

The electricity programme for which approval was being sought represented the most ambitious programme of national development which had ever been undertaken in Ireland, said Mr. Lemass in the Dail on 24th March, when he moved the second reading of the Electricity (Supply) (Amendment) Bill. From 60,000 to 70,000 acres of bog would be developed for electricity production, giving permanent employment to about 4,000 men. Some 1,000 men, many of them skilled, would be employed in the new stations and on the transmission systems. An important stage in the development programme was the decision in 1952 to embark on the development of milled peat. All the indications were that through the use of peat fuel costs of electricity generation would be as low as in any country in Europe.

Littondale Valley Supply

Settle Rural District Council has been informed that there appears to be little prospect of underground cable being used for extending the electricity supply up the Littondale Valley. The Council's Plans Committee recently met representatives of the Yorkshire Electricity Board to press for the cable to be placed underground in order to preserve the amenities of this particularly beautiful district, but it was stated that the cost would be increased fivefold and the scheme would thus become prohibitive. Replying to the Council's alternative plea for the cable to be put underground in the villages of Arncliffe and Hawkswick, the Board pointed out that in Arncliffe alone this would entail an increase of £700 in the cost. An assurance was given that the poles would be sited so as to cause the least possible injury to the local amenities.

Jubilee Year at Christchurch

Last year was the fiftieth in the existence of the municipal electricity undertaking at Christchurch, New Zealand, a supply having first been made available on 25th July, 1903, from steam plant associated with the destructor. In the whole of that period, says the engineer-manager (Mr. J. C. Forsyth, B.Sc., M.I.E.E.) in his report, retail charges have been consistently reduced. Unfortunately the jubilee year saw a sharp reversal of this trend, primarily as a result of the revised bulk supply charges of the State Hydro-Electric Department. These have raised the cost of bulk power by from 35 per cent in the case of small undertakings to 67 per cent for the largest. It was found necessary to increase revenue by 52 per cent, and new tariffs were devised on this basis. Besides this, the undertaking's finances were adversely affected by drastic sales restrictions made necessary by drought; it is estimated that over £20,000 of revenue was lost in this way, with practically no compensating reduction in the cost of bulk power. Domestic appliance sales at the undertaking's showrooms brought a 45 per cent increase in turnover, the number of cookers sold being 588 (against 540 in 1952), refrigerators 152 (against 84) and washing machines 297 (against 64). With higher prices and reduced building activity, however, there has been a tendency for the demand for cookers to ease.

Lake District Supply Scheme

At a meeting at Carlisle of the North East Lakeland District Committee of the North Western Electricity Consultative Council it was announced that work would begin in twelve months' time on a £225,000 scheme for supplying electricity to the Ivegill area. It was stated that the scheme would take three or four years to carry out and about 400 premises, including 200 farm buildings, would be supplied with electricity.

B.E.A. and Farmers

With the coming into operation this year of the Milk and Dairies Regulations it is common justice that farmers should have the benefit of a supply of electricity to facilitate compliance with the regulations. This point was made in a resolution passed at a meeting of the Blackawton, Devon, Council at its March meeting. The resolution, " presuming the acceptance under the 1947 Electricity Act of their joint responsibility with the Area Boards for the electrification of rural areas," requested the British Electricity Authority to prepare and publish details of a scheme for such electrification " and thus enable farmers . . . to plan accordingly for the betterment of agriculture in general and the production of food in particular." Mr. C. J. Barnett, chairman of the Electricity Committee, said that it had been an uphill task getting the Central Authority to admit responsibility for a scheme for nation-wide rural electrification. This year would mark the commencement of a new era in dairying hygiene, and the farms without electricity would be at a serious disadvantage in their efforts to keep within the law.

Financial Section

STOCKS and SHARES

WITH the approach of the Budget reducing ordinary investment business to bare essentials, interest in the Stock Exchange has been centred mainly on the result of the I.C.I. issue of 4½ per cent loan stock. Dealings were due to begin yesterday, 1st April. An earlier official announcement said that 52,800 applicants had subscribed for more than ten times the £30 million stock offered. No industrial issue has ever attracted money on this scale before. Although applicants had to put up cash to the extent of only 10 per cent, it is clear now that the tying-up of so much money must have been acting as a damper lately on the industrial market. Prices there have nevertheless been firm, which encourages the hope that more spring-like conditions may return to the House later this month.

Brush Results

The 6 per cent dividend and the profit figures announced by Brush Electrical Engineering were in line with market expectations, and left little change in the price of the 5s shares. The distribution is a 2 per cent improvement on last year's, and can be calculated to be covered nearly three times by the year's surplus on ordinary trading account. This leaves out of the reckoning the final provisions for losses on the Indian tube-well contracts: appropriations are being made from reserves for that purpose. With the end of that matter in sight, and having regard, also, to last year's capital raising and the interest taken lately by the Thos. Tilling group, the market disposition is to regard the shares as being at the opening of a new phase. Their present yield of about 5 per cent implies satisfaction with the further prospect.

Lucas Distributions

J. Lucas (Industries) £1 shares responded with a rise of 5s 9d to 63s 9d, to the company's announcement of an increase in the interim dividend for the current year from 4d to 6d per share, and of a proposed share-for-share capital bonus. Profit-taking caused a reaction to 62s 6d. For a long time the price of the shares has been influenced by the conspicuously wide difference existing between the rate of dividends and the scale of the earnings on the one hand, and, on the other, between the nominal capital and the amount of money actually invested in the business. In taking steps now to narrow the disparity in both respects, the company is ahead of expectations, for it was only a few months ago that the question of dropping interim dividends altogether had been under review. It is the company's intention to obtain shareholders' authority to issue further preference shares to the Lucas Workers' Share Bank.

Price Changes

Electrical equipment shares have again made a rather mixed showing

Week's Price Changes

Company or Board	Nom. Value	Middle price 29th Mar.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1953 Highest	1953 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	90		3	3	3 6 9	90	83 11/16
Brit. Elec. 1974/77	100	89½	+½	3	3	3 7 0	89	82
Brit. Elec. 1976/79	100	96		3½	3½	3 13 0	94¾	88⅝
Brit. Elec. 1974/79	100	104½		4¼	4¼	4 1 3	104	99⅛
Overseas Electric Supply								
Calcutta Elec.	£1	19/6	−6d	6†	6†	6 3 0†	21/-	18/-
East African Power	£1	21/9	−9d	7	7	6 8 9	25/-	20/9
Nigerian Elec.	£1	23/6		10	10	8 10 3	25/-	21/6
Palestine Elec. "A"	£1	18/-		Nil	Nil	Nil	19/3	7/7
Perak Hydro-Elec.	£1	15/		Nil	6	8 0 0	17/10	13/6
Equipment and Manufacturing								
Aberdare Cables	5/-	8/3		20	20	7 7 0°	8/9	7/4
Aerialite	1/-	11/6	−3d	88⅓	88⅓	7 13 9	11/6	8/1
Allen, W. H.	£1	55/9		15	15	5 7 6	51/-	42/10
Aron Elec. Ord.	£1	45/-		15	20	8 17 9	47/6	36/3
Assoc. Elec. Ord.	£1	44/6	−3d	20	11¼°	5 0 6	45/7	36/4
Automatic Tel. & El.	£1	64/6	−6d	15	15	4 13 0	65/3	55/-
Babcock & Wilcox	£1	49/-	−1/-	18	18	—	50/-	40/4
Baldwin, H. J.	2/-	4/6		20	20	8 18 0	4/1	3/-
Bakelite	10/-	25/-	+1/-	12½	12½	5 0 0	24/9	16/-
British Aluminium	£1	39/-	+1/-	12	12	6 3 0	43/10	35/-
B.I. Callender's	£1	39/6	−6d	9	10	5 1 3	40/10	33/3
B.I. Callender's 6% Pref. ...	£1	26/-		6	6	4 12 3	26/3	23/-
British Thermostat	5/-	20/-		30	35	—	19/-	14/-
British Vac. Cleaner	5/-	13/3		25	25	9 8 9	16/6	11/-
Brook Motors	10/	35/6		20	20°	5 12 9	37/-	27/10
Brush Ord.	5/-	6/-		4	6	—	5/4	2/11
Bulgin, A. F.	1/-	3/4½		30	30	8 11 6	3/4	2/6
Burco	5/-	12/9	−3d	35	35	6 17 3°	12/2	8/6
Chloride El. Storage	£1	52/6	+2/6	15	20	3 16 3°	44/10	32/3
Clarke Chapman	£1	75/9		17½	20	5 5 6	70/6	57/6
Cole, E. K.	5/-	24/-		25	25°	5 4 3	23/9	14/2
Cossor, A. C.	5/-	7/6		10	10	6 13 4	11/4	6/4
Crabtree	10/-	25/9	−6d	17½	17½	6 16 0	32/6	23/9
Crompton Parkinson Ord. ...	5/-	16/-		11½	20	6 5 0	16/-	8/7
De La Rue	5/-	13/6	−3d	35	Nil	Nil	14/6	6/3
Decca	4/-	34/6	−9d	150	35°	—	37/9	17/6
Desoutter	5/-	18/3	+6d	18	20	5 9 6	17/6	14/3
Dewhurst	2/-	5/6		19	19	6 18 3	6/9	5/-
Dictograph Tel.	2/-	5/9		20	20°	6 19 3	5/10	3/10
Dubilier Condenser	1/-	5/-	+3d	28	25°	5 0 0	4/4	2/10
E.M.I.	10/-	13/6	−3d	12	8	5 18 6	15/3	11/6
Electrical Components	5/-	11/3		20	20	8 17 10	12/-	9/3
Elec. Construction	£1	56/3		15	15	5 6 8	56/-	50/6
Enfield Cable Ord.	£1	17/6		7½	5	5 14 3	24/10	17/-
English Electric	£1	40/-		15	10°	5 0 0	40/8	34/-
English Electric 3½% Pref. ...	£1	15/6		3½	3½	4 15 3	16/4	14/6
Ericsson Tel.	5/-	46/3	−1/3	22†	25†	2 14 0†	48/9	36/-
Ever Ready	5/-	27/6	+6d	35	35	6 7 3	29/-	25/-
Falk Stadelmann	£1	40/-		15	15	7 10 0	44/3	38/3
G.E.C. Ord.	£1	39/6	−6d	22½	11¼°	5 14 0	46/-	36/3
G.E.C. 6½% Pref.	£1	27/-		6½	6½	4 16 3	27/7	24/9
General Cables	5/-	16/9		30	30	8 19 2	17/-	14/9
Greenwood & Batley	£1	43/9		15	17½	8 0 0	41/6	38/-
Hackbridge Cable	5/-	13/6		20	20	7 8 3	13/-	10/4
Hackbridge & Hewittic	5/-	18/6		20	20	5 8 0	18/3	16/1
Hall Tel. Acc.	10/-	11/6		10	10	8 13 10	12/7	8/6
Heatrae	2/-	4/-		12½	12½	6 5 0	4/3	3/3
Henley's	10/-	16/-	−6d	20	10½°	6 11 3	19/4	16/-
Holophane	5/-	14/9		20	20	6 15 7	13/9	11/1

* After capital bonus. † Free of income tax.

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.

during the week. Among the leaders, G.E.C. and A.E.I. were marked down by a few pence, and English Electric were dealt in around 38s 9d. Parsons and Reyrolle receded together 1s 3d in advance of the coming dividend declarations. Ericssons were lower by a like amount, and one or two of the cable manufacturers' shares went easier. Rises occurred mainly in the shares of other companies due to declare dividends shortly, Chloride Electricals being particularly strong in adding half-a-crown. Ever Ready were also better, and Plesseys went further ahead. Other improvements worthy of note occurred in Hoovers (on which the yield attracts attention), S. Smith, Bakelite, Desoutter and Dubilier. Bagdad Light & Power fell sharply to 61s 3d upon news of floods in the area.

...in Electrical Investments

Company or Board	Nom. Value	Middle price 29th Mar.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield % £ s d	1953 Highest	1953 Lowest
Equipment and Manufacturing—continued.								
Hoover	5/-	32/9	+1/9	25	45	—	26/10	20/3
I.C.I.	£1	56/6		13	15	5 6 2	54/-	41/6
Intl. Combustion	5/-	19/6	+6d	15	20	5 2 6	15/6	12/1
Johnson & Phillips	£1	51/-		15	15	5 17 9	59/3	49/-
Lancashire Dynamo	£1	46/3		12½	12½	5 8 0	47/-	41/-
Laurence, Scott	5/-	16/9		15	15	4 9 6	14/6	11/9
Lister, R. A.	£1	35/9		9	12	6 14 3	34/3	27/9
London Elec. Wire	£1	38/6	—6d	12½	15	3 18 0°	38/3	26/-
Lucas, J.	£1	62/6	+3/3	9⅛	10⅝	—	51/3	35/6
Marryat & Scott	2/-	6/6		22½	22½	6 18 6	6/3	5/1
Mather & Platt	£1	55/6		12½	15	5 8 0	53/10	41/3
Metal Industries	£1	30/3	—1/-	15	12°	7 18 6	47/9	37/9
Midland Elec. Mfg.	£1	63/3		15	15	4 14 9	63/9	56/3
Morphy-Richards	4/-	14/6		40	40	—	16/3	13/-
Murex	£1	51/-		15	15	5 17 8	60/9	50/6
Newman Ind.	2/-	2/3		10	10	8 17 9	2/10	2/-
Oldham & Son	1/-	2/9		35	17½°	6 7 3	2/10	2/2
Parnall (Yate)	5/-	6/3		6	6	4 16 0	4/9	2/6
Parsons, C. A.	£1	41/3	—1/3	10°	12½	—	48/-	27/9
Plessey	5/-	47/3	+1/3	25	30	3 3 6	37/-	20/1
Pye Deferred	5/-	20/-		18	20	—	16/3	10/6
Revo	10/-	17/6		27½	27½	—	17/6	13/11
Reyrolle	£1	71/3	—1/3	10°	12½	—	79/-	51/-
Rheostatic	4/-	12/-		19	20	6 13 4	12/-	8/-
Richardsons Westgarth	5/-	11/-		12	15	6 16 3	11/1	8/6
Scottish Cable	4/-	14/3		32	20°	5 12 3	13/3	11/1
Siemens Ord.	£1	37/6	—6d	10	10	5 6 8	37/-	31/6
Smith (England), S.	4/-	9/-	+3d	12½	15	—	12/6	7/11
Southern Areas	£1	18/-		5	6	6 13 4	19/7	10/3
Strand Elec.	5/-	8/9		17½	17½	10 0 0	10/-	7/9
Sturtevant	5/-	33/9		17¼†	18·1†°	—	29/9	20/10
Sun Elec.	£1	27/6		15	15	10 18 3	27/-	24/6
Switchgear & Cowans	5/-	10/-		22½	10	5 0 0	16/9	12/6
Taylor Tunnicliff	5/-	11/3		25	12½°	5 11 0	12/3	9/6
T.C.C.	10/-	45/-	+6d	20	20°	—	42/6	31/5
T.C. & M.	£1	30/9		10	8⅛°	5 10 6	31/6	25/6
Telephone Mfg.	5/-	8/6		10	10	5 17 8	9/4	7/1
Thorn Elec.	5/-	17/-		12½	12½	3 13 6	14/-	7/10
Thornycroft	£1	35/-		15	15	8 11 6	54/-	29/9
Tube Investments	£1	61/3		15°	15	4 18 0	71/9	54/-
Vactric	5/-	9/6		Nil	Nil	Nil	10/3	3/6
Veritys	5/-	6/6		7½	10	7 13 9	5/4	4/1
Walsall Conduits	4/-	47/-		70	70°	5 19 3	47/6	43/9
Ward & Goldstone	5/-	45/-		45	45°	5 0 0	46/-	29/9
Watford	2/-	6/3		25	25	—	5/6	4/10
Westinghouse Brake	£1	67/6		14	15	4 9 0	64/-	51/3
West, Allen	5/-	14/9	—3d	15	15	5 1 9	14/4	10/3
Wolf Electric	5/-	13/-		15	17½	6 14 6	12/8	9/6
Trusts, Transport and Communications								
Anglo-Am. Tel.: A Ord.	100	87½	—2	—	6	6 17 3	91	77
Ord.	100	55½		—	3¾	6 15 3	57½	53
Anglo-Portuguese	£1	21/-		8	8	7 12 6	23/9	20/1
Brit. Electric Traction: Def.	5/-	42/6	—6d	25	35	4 2 3	39/6	21/3
Cable & Wireless: Ord.	£1	34/-		8	9	5 6 0	148	124
4% Loan	100	96½		4	4	4 3 0	97¾	93
Calcutta Trams	£1	18/-		6†	2½†	—	23/6	16/-
Cape Elec. Trams	£1	14/6		5½	5½	7 11 9	13/-	9/-
Marconi Marine	£1	28/3		10	10	7 1 7	31/6	26/9
Oriental Tel. Ord.	£1	79/-	—6d	16	16	—	75/-	59/-
Telephone Props.	£1	4¾		8	8	—	126/3	33/-
Telephone Rentals	5/-	9/6		10	10°	—	10/-	6/8

Wolf Electric Dividend

The 5s shares of Wolf Electric Tools (Holdings), which were introduced to the Stock Exchange three years ago, have changed hands at about 12s 9d since the announcement of an increase in the dividend from 15 to 17½ per cent on the £318,400 ordinary capital. With the aid of lower tax provisions this time, the net group profit comes out £40,000 higher at £91,000, so that the larger dividend distribution still remains well in the conservative class, with a nearly three-fold earnings cover. The yield on the shares, at the new dividend rate, comes to approximately 6¾ per cent.

Decca Preference

A 7 per cent yield is available from the new Decca Record 5s 25 per cent preference shares at their present price of 17s 9d. These shares result from the recent division of the company's old 5s ordinary shares into an equal number of 4s shares and a quarter the number of preference. The latter rank after two senior preference issues, and would be repayable at 20s in the event of a winding-up. Dividends on the new preference will require an amount of under £18,000 net annually.

Telephone and General Dividend

A good market reception was given to the announcement of a final dividend of 7 per cent on Telephone & General Trust £1 ordinary shares. This brings the total for 1953 to 10 per cent, and breaks the long line of annual payments at the rate of 8 per cent. In addition, there is a proposal to issue shareholders with a bonus of one new share for every ten shares held. From 37s 6d the price of the shares has been marked up to close on 40s. Group net profits have expanded by nearly 20 per cent.

Franco Signs

Another improvement in the trading profit of Franco Signs, during the year ended last September, carries on the upward trend of previous years. So far as the net profit is concerned, the increase in the surplus at £59,000 is kept to small proportions by a larger tax charge, which includes £14,000 for the excess profits levy. Since the latter absorbs not much less than the net amount of the ordinary dividend, its removal from the beginning of this year should be particularly welcome in such a case. There is to be no change this time in the rate of dividend, which was raised a year ago from 7½ to 10 per cent, and the 10s shares remain quoted at about their par value.

REPORTS and DIVIDENDS

Mather & Platt, Ltd.—Another satisfactory year's trading was reported by Mr. L. E. Mather (chairman), at the annual meeting held on 25th March. Referring to exports he said that the lack of exchange facilities had particularly affected their trade with Brazil and Argentina. A gratifying feature had been the increased amount of dollar business obtained from the United States and Canada. The French company was obtaining more business and they had re-established the subsidiary company in Germany. Turkey had provided some important contracts for textile-finishing plant, and interest shown by the U.S.S.R. in capital equipment manufactured in this country included their textile-finishing machinery.

Home business in all departments had improved during the year, and important contracts had been received for heavy plant in connection with the generation of electricity by atomic energy. The prospects for 1954 were good.

R. A. Lister & Co., Ltd.—Speaking at the annual meeting held on 25th March, Sir Percy Lister (chairman) said that the abnormal trading conditions to which he referred last year continued throughout the year under review, particularly in the export trade where many markets, through currency difficulties, had been virtually closed, and in the Commonwealth and Empire markets quotas and other restrictions had seriously restricted trade. The Australian subsidiary had been particularly adversely affected by the economic difficulties, but the addition of a modern mechanized foundry which was opened at the Australian factory in April last year should have added strength to the Australian company's activities. There were indications of improvement in trade in Australia. By cultivating markets in which their interests were not fully developed, or in which trading conditions had improved, they had received a substantially increased volume of trade in such markets. The home and overseas demand for their electric generating units and marine propulsion and auxiliary engines had shown a gratifying expansion. The current order book was in a healthy condition.

Hilger & Watts, Ltd.—The annual meeting was held on 25th March, when Mr. G. A. Whipple (chairman and managing director), who presided, referred to the removal of the major part of the production of the Camberwell establishment to the new factory at Debden. The whole of the new building was now occupied and had become the largest of their production units. With regard to research and development two major projects had come to fruition. The first was a direct-reading spectrograph, a "polychromator," designed for the rapid routine analysis of complex metallic alloys and the second instrument was a photogrammetric plotting machine for precise mapping from aerial photographs.

The cuts in the rearmament programmes of the Western Powers had affected sales both at home and in the North American markets, but other overseas markets such as india, Australia and Japan were expanding.

The Brush Electrical Engineering Co., Ltd., in a preliminary statement, reports a net profit, after all charges including taxation, of £404,078 for 1953. This is not comparable with the £136,990 for 1952 as in that year the Indian tubewell loss, after tax relief, of £308,970 was written off the year's profits. The tubewell loss for 1953 of £159,877 after taking into account taxation relief, was covered by the amount of £180,000 taken from general reserve in 1952, and there is therefore no charge to tubewell loss in the 1953 profit and loss account. A further provision of £250,000 has been made for further estimated losses. It is proposed to pay a dividend for the year of 6 per cent (against 4 per cent), and to carry forward £349,216 (against £332,254 brought in).

The British Oxygen Co., Ltd.—The accounts for 1953 show a group trading profit, after deducting depreciation, of £4,324,975, as compared with £3,975,092 for 1952. The net profit of the British Oxygen Co. is £1,479,124 of which £485,384 is retained by subsidiaries. It is proposed to pay a final ordinary dividend of 9 per cent, making 15 per cent for the year. This is at the same rate as for 1952, but the interim dividend of 6 per cent in 1952 was paid before the rights issue.

Charles Clifford, Ltd., reports a consolidated trading profit for 1953 of £29,228 as compared with £171,929 for 1952, and a net profit of £3,303 (against £82,702), of which £648 is retained by subsidiary companies. It is proposed to pay a final ordinary dividend of 8½ per cent making 12½ per cent for the year. This is equivalent to 25 per cent for 1952 on the ordinary capital before the 100 per cent scrip issue.

In his circulated statement Mr. E. A. Norton (chairman) says that in addition to a serious recession in the non-ferrous industry, they have been faced with a heavy loss as a result of the fall in the price of metals. Uncertainty regarding the future is exercising a restrictive effort on important long-term buying.

Franco Signs, Ltd., reports a trading profit for the year ended 30th September last of £130,831, as compared with £119,736 for the preceding year, and after meeting all charges, including £58,770 for taxation, there is a net balance of £29,774 (against £29,331). Reserves receive £40,933 and it is proposed to pay an unchanged dividend for the year of 10 per cent. The balance carried forward is £45,516 (against £75,342 brought in).

Wolf Electric Tools (Holdings), Ltd.—The accounts for 1953 show that after providing for taxation of £161,050, the group profit is £91,479, as compared with £51,775 for 1952. A sum of £55,000 is transferred to general reserve in the accounts of the subsidiary, and it is proposed to pay an ordinary dividend of 17½ per cent for the year (against 15 per cent). The balance carried forward is £37,315 (against £21,164 brought in).

The Telephone & General Trust, Ltd.—The group profit for 1953, after meeting all charges, including £126,794 for taxation, is £232,409, as compared with £194,969 for 1952. It is proposed to pay a final dividend of 7 per cent (against 5 per cent), making 10 per cent (8 per cent) for the year. It is also proposed to pay a dividend for the year on the "A" ordinary stock of 10 per cent (against 8 per cent).

At the forthcoming annual meeting a proposal will be submitted that a bonus issue of 110,000 ordinary shares of £1 each be given to stockholders out of capital reserve in the proportion of one new ordinary share for each £10 of ordinary and "A" ordinary stock held.

Radio Rentals, Ltd., has declared an interim dividend of 10 per cent actual on the 906,820 ordinary shares (same). The 90,682 new ordinary shares of 5s each about to be offered to ordinary shareholders at 11s per share will not rank for this dividend.

New Companies

H. F. Scriven, Ltd.—Registered 26th February. Capital £5,000. Electrical contractors, manufacturers, wholesalers, distributors, importers and repairers of and dealers in electrical goods, etc. Directors: H. F. Scriven and Violet M. Scriven. Regd. office: 37, High Town Road, Luton, Beds.

Automatic Electric Co., Ltd.—Registered 8th March. Capital £100. Manufacturers of and dealers in automatic and other telephones, telegraphs, wires, cables, lines and other appliances, etc. The first directors are not named. Solicitors: Hill Dickinson & Co., 10, Water Street, Liverpool.

Duncan, Partners & Price, Ltd.—Registered 11th February. Capital £3,000. Manufacturers of and dealers in all kinds of lamps, lights, shades and other lighting equipment, etc. The first directors are to be appointed by the subscribers. Regd. office: Bond Street House, 14, Clifford Street, London, W.1.

Telephone & Industrial Services, Ltd.—Registered in Belfast, 18th January. Capital £2,000. To acquire the business of Douglas H. Johnston and Joyce C. Thompson, manufacturers of and dealers in and agents for telephonic, radio, television and electrical apparatus, etc. Directors: Mrs. Joyce C. Thompson and D. H. Johnston.

H. & M. Electrical (London), Ltd.—Registered 24th February. Capital £1,000. Electrical engineers and contractors, etc. Directors: A. F. Moxon, D. Hammond, C. L. Moxon, and C. D. W. Moxon. Regd. office: Station Buildings, Bruce Grove, Tottenham, N.17.

W. H. Fryer & Co., Ltd.—Registered in Dublin, 18th January. Capital £15,000. To acquire the business of an electrical engineer carried on by William H. Fryer as "W. & P. Fryer" at 6A, Merrion Road, Ballsbridge, Dublin. Directors: W. H. Fryer and Mrs. Catherine E. Fryer.

C.T.L. Wires & Cables, Ltd.—Registered 17th March. Capital £2,500. The first directors are not named. Solicitors: Fink Proudfoot & Waters, 317, High Holborn, W.C.1.

Neon, Signs & Lighting, Ltd.—Registered 17th March. Capital £1,000. Manufacturers, exporters and importers of and dealers in vacuum discharge tubes and lamps, electric lamps, radio valves, etc. Directors: F. H. Pues (permanent) and E. Martin. Regd. office: 225, High Road, Ilford, Essex.

Pope and Luffman, Ltd.—Registered 19th March. Capital £3,200. Electrical engineers and general electrical installation contractors, etc. Directors: W. F. Pope and P. G. Luffman. Regd. office: 50, Kings Parade Avenue, Bristol, 8.

W. M. Baldwin & Co., Ltd.—Registered 20th March. Capital £5,000. Electricians, radio television and mechanical engineers, etc. Directors: W. Baldwin, Mrs. Eileen A. D. Baldwin, and A. Smith. Regd. office: 26, Poplar Road, Solihull, Warwicks.

A. E. Hutchings, Ltd.—Registered 20th March. Capital £4,000. To acquire the business of an electrical engineer and contractor carried on by A. E. Hutchings at Grenville Works, Kingsley Road, Bideford, Devon, as "A. E. Hutchings & Co."; and to carry on the business of electrical, radio, television, electronic, mechanical, civil, general engineers, etc. Directors: A. E. Hutchings (chairman and managing director), Betty F. Hutchings and M. T. Hutchings. Solicitors: F. A. Goaman & Wright, Bideford.

Electro Farm Equipments, Ltd.—Registered 15th March. Capital £2,000. Electrical engineers and general electrical installation contractors, etc. The first directors are to be appointed by the subscribers. Regd. office: Clumber Buildings, Clumber Street, Nottingham.

Liquidations

Fox & Co. (Childwall), Ltd., electrical contractors and radio engineers.—Winding up voluntarily. Liquidator, Mr. S. O. Henry, 5, Rumford Place, Liverpool, 3, appointed 17th March.

Selways Neon Lighting of Wales, Ltd.—In voluntary liquidation. Particulars of claims by 14th April to the liquidator, Mr. G. G. Thomas, 7–10, Oxford Buildings, Lower Union Street, Swansea.

Bankruptcies

L. J. Quick, 2, The Mall, Ealing, London, W.5, electrical distributor.—Second and final dividend 1s 0½d in the £, payable on and after 31st March at 25, Bedford Row, London, W.C.1.

H. Pryor, electronic engineer, carrying on business as W. Pryor at 36, Low Hill, Liverpool, 6.—Receiving order made 22nd March on debtor's petition.

Steam Atmosphere Furnaces

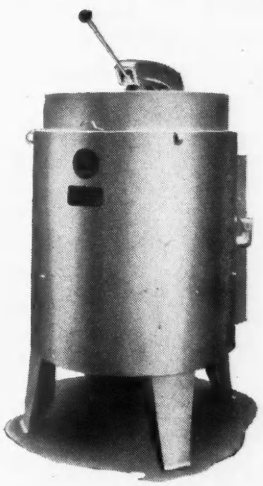
IT has been known for many years that electrical components such as laminations and shafts can be heated in a furnace in a steam atmosphere at about 500 to 550 deg C and that this treatment will produce a bluish oxide surface which is an electrical insulator. Steam atmospheres have also been employed in furnaces for the protection of the surfaces of brass and nickel silver during annealing. In recent years it has been found that high speed steel drills can also be heated in a steam atmosphere at a temperature of about 550 deg C with a resultant very pleasing blackish-blue surface which is actually an adherent skin of ferrosopheric oxide.

This oxide coating, in addition to being rust resisting, gives added life to drills when carrying out certain operations, but the main advantage is that these precision-made components can be heat-treated without the need for a final grinding operation after the last secondary hardening treatment. A further and more recent application of the steam atmosphere furnace is for the treatment of ferrous sintered products after the actual sintering operation; it is claimed that greater hardness is thereby obtained.

Birlec, Ltd., of Birmingham, have supplied furnaces in the past specially adapted for use with steam atmospheres, including both batch and flow production equipments, but to meet the demand for a standard furnace for blueing such components as drills, electrical parts and other articles they have developed a new range of furnaces for use with a steam atmosphere and capable of operation at temperatures up to 700 deg C.

The furnace is of the vertical, cylindrical type and is built on orthodox lines with a brick-lined steel shell. An interior metal container covers the main brickwork so that the furnace bricks will not absorb the steam. A hand operated cover or lid is supplied and the lifting equipment is designed so that no elaborate clamping methods are needed to ensure a gas-tight seal. Insulators are mounted on the inner face of the metal container to carry the heating elements, an arrangement which ensures that heat is imparted direct to the charge by means of the air circulation system. A centrifugal fan and suitable baffles ensure uniform temperature throughout the charge space. Steam is admitted to the furnace chamber near the fan and the outlet is provided at the top of the chamber with drain valves at suitable points. The steam, which need only have a pressure of a few pounds, can be taken from the normal factory supply or a small boiler. All possible sources of leakage, such as the fan shaft, etc., are sealed.

The new standard furnace can be employed for heat treatment applications other than steam atmosphere work where temperatures up to 700 deg C are required.



The new "Birlec" standard-type steam atmosphere furnace

Lighting Notes

CAMBERWELL Works Committee reports that the Minister of Transport is prepared to consider proposals for the modernization of the existing Grades "D" and "E" street lighting lamps, during the forthcoming financial year to an amount totalling £15,000 only. The Committee is of opinion that the modernization of all existing Grade "D" lamps at an estimated cost of £10,921 should be given preference and authority has been given to the borough engineer to obtain tenders from selected firms for the carrying out of this work.

A quotation has been accepted by RUGELEY U.D.C. for the lighting and maintenance of all lamps within the urban district. The terms quoted by the Midlands Electricity Board provide for erecting and maintaining 107 new lighting points converted from gas at £5 4s per lighting point per annum (dusk to midnight from 1st September to 15th May). The Board is prepared to maintain 288 existing electric lamps for £3 8s each per season, excluding all-night lamps.

BASINGSTOKE Corporation proposes to seek sanction to borrow £4,830 for improving the lighting in Brook Street, Chapel Street and Kingsclere Road.

OXFORD Highways, Sewers and Lighting Committee proposes to replace gas street lighting in a section of Parks Road between Banbury Road and South Parks Road at a total estimated cost of £1,000.

NEW BOOKS

Electrical Breakdown of Gases. By J. M. Meek and J. D. Craggs. Pp. 507; figs. and index. Oxford University Press, Amen House, London, E.C.4. Price 60s.

The subject of arc discharge, breakdown, lightning and corona is of importance to all electrical power engineers; this book is a comprehensive survey of recent research and theory. It contains most of the important advances up to the end of 1951, and an appendix of 21 pages deals in précis form with the more important papers of 1952.

Since the book is primarily designed for students of fundamental research, it requires a sound background in both mathematics and molecular physics, but it could be of great use to the less technical man due to the clear style, many figures with graphs of test results, photographs of arc phenomena, oscillograms, etc.

The subject matter includes breakdown in gas at normal and low pressures, corona, spark discharge and lightning, voltage characteristics, irradiation and time lags, high frequency effects, the channel effects of electrodes and glow to arc transition. The index is well designed to give separate authors and subjects, and references are given at the end of each chapter (Chapter One having 224).

The importance of this book is not in its contents, for much of it could be found in original papers, but in the concise nature in which it is presented: e.g., the matter of following the theory of corona alone, through "abstracts" and technical literature (much of which is American or Continental), necessitates many hours of work in a good library. Undoubtedly this book will be rated as one of the most important in this somewhat complicated field.—E.H.S.

An Introduction to Power System Analysis. By Frederick S. Rothe. Pp. 187; figs. and index. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 40s in United Kingdom.

To review and consolidate information is often more valuable than to present new knowledge, and this is particularly so in the field of power system analysis. In this further volume in the General Electric Series, Mr. Rothe claims to summarize into a unified set of notes the fundamental tools of system analysis developed during the last twenty years. He has achieved his object in a very concise manner, using vector algebra to a considerable extent throughout.

Two-winding and multi-winding transformers are reduced to equivalent circuits and methods of evaluating their phase sequence impedances formulated. The section on zero phase sequence connections for transformers is particularly valuable. The fundamentals of symmetrical components are presented, and the use of $\alpha\ \beta\ o$ or Clarke components in system analysis is explained. The elementary theory of sychronous machines is given, and two chapters are devoted to the analysis of faults and suddenly applied loads at generator terminals and on systems. The phase sequence impedances of overhead transmission lines, steady-state transmission line theory, and the fundamentals of power system stability form the subject matter of the final three chapters of the book.

The publication is essentially an introduction to the subject and is suitable for graduate or junior engineers wishing to learn the fundamentals of power system analysis. It does form, however, a useful reference book for the practising power system engineer. No numerical values of plant constants are given, and a selection of typical values would improve the text.—K.W.W.

Industrial Electronics. By R. Kretzmann. Pp. 250; figs. and index. Philips' Technical Library. Cleaver-Hume Press, Ltd., 42a, South Audley Street, London, W.1. Price 25s.

This book is intended as an introduction to industrial electronic practice, and is directed towards those who are likely to use or to have to maintain the equipment described. Nearly all the vacuum devices illustrated are commercial types and designs manufactured by the Philips Company. The material is rather different from that of many books on this subject. Instead of the usual theoretical introduction, the first part of the book deals straight away with the properties and characteristics of various types of electronic tube.

The first chapter gives a good concise description of the characteristics of amplifying and transmitting valves and some of their basic circuits. It is questionable, however, if the explanations of how the devices work, very brief and devoid of physics as they are, would explain anything to anyone who had not already a good idea of their principles of operation. There follow chapters on other devices such as vacuum and gas-filled rectifiers, gas-filled relays, ignitrons, stabilizers, photocells and cathode-ray tubes. This material is well chosen as likely to be that of chief interest to industrial engineers, although many of these would wish to seek further for additional information concerning the scientific principles of operation of the devices.

The second part of the book deals in some detail with many of the major applications, of which relay and counting circuits, control circuits for welding and motors, high frequency heating, tuning circuits, temperature control are a few examples. This is by far the better part of the book, and makes interesting reading for anyone whose curiosity lies in this direction. The writing is lucid and authoritative, the diagrams and presentation good. There could, however, with advantage be a much wider selection of references.—V.J.F.

BOOKS RECEIVED

Electrical Earthing and Accident Prevention. Edited by M. G. Say, Ph.D., M.Sc., M.I.E.E. Pp. 248; figs. and index. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 25s.

Information Theory. By Stanford Goldman. Pp. 385; figs. and index. Constable & Co., Ltd., 10, Orange Street, London, W.C.2. Price 50s.

Techniques of Technical Training. By H. R. Mills. Pp. 195; figs. 39; index. Cleaver-Hume Press, Ltd., 42a, South Audley Street, London, W.1. Price 10s 6d.

Modern Armature Construction Winding and Repair. By S. F. Philpott. Pp. 280; figs. and index. Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 30s.

Introductory Circuit Theory. By E. A. Guillemin. Pp. 550; figs. and index. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 68s.

Electrical Contractor's Annual. Edited by J. Roslyn-Stuart. Pp. 358. E. & F. N. Spon, Ltd., 15, Bedford Street, London, W.C.2. Price 18s.

Manual for Plastic Welding. By G. Haim and J. A. Neumann. Pp. 128; figs. and index. Crosby Lockwood & Son, Ltd., 39, Thurloe Street, London, S.W.7. Price 30s.

NEXT WEEK'S EVENTS

Organizers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged

Monday, 5th April

BIRMINGHAM.—Imperial Hotel, 6 p.m. I.E.E. South Midland Supply and Utilization Group. "The Electrolytic Analogue in the Design of High-Voltage Power Transformers," by D. McDonald.

BOLTON.—Balmoral Hotel, Bradshawgate, 7.30 p.m. A.S.E.E. Bolton Branch. "Lightning Conductors," by Mr. Harland.

DUNDEE.—Mathers Hotel, 7.30 p.m. Incorporated Plant Engineers, Dundee Branch. "Industrial uses of Magnetic Power," by T. G. Hawker.

ILFORD.—Angel Hotel, 8 p.m. A.S.E.E. North-East London Branch. "Electric Equipment on the Automobile," by R. J. Smith.

IPSWICH.—Crown and Anchor Hotel, 6.30 p.m. I.E.E. Ipswich district meeting. Informal meeting.

LEEDS.—Great Northern Hotel, 7.30 p.m. A.S.E.E. Leeds Branch. "Transformer Manufacturing Technique," by R. M. W. Grant.

LIVERPOOL.—At the Royal Institution, Colquitt Street, 6.30 p.m. I.E.E. Mersey and North Wales Centre. Annual general meeting. "Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies on 2nd June, 1953," by W. S. Procter, M. J. L. Pulling and F. Williams.

LONDON.—Savoy Place, 5.30 p.m. I.E.E. Radio Section. Discussion on "Technical Problems involved in Receiving Alternative Television Programmes."

NEWCASTLE-UPON-TYNE.—King's College, 6 p.m. I.E.E. North-Eastern Radio and Measurements Group. Annual general meeting followed at 6.15 p.m. by informal meeting in the form of demonstrations.

SHEFFIELD.—Royal Victoria Station Hotel, 7.30 p.m. A.S.E.E. Sheffield Branch. Lecture.

STAFFORD.—Technical College, 7 p.m. I.E.E. North Staffordshire Sub-Centre. Annual general meeting, followed by "Technical Colleges and Education for the Electrical Industry," by Dr. H. L. Haslegrave.

Tuesday, 6th April

EDINBURGH.—Carlton Hotel, North Bridge, 7 p.m. I.E.E. South-East Scotland Sub-Centre. "The Co-ordination of Insulation of High-Voltage Electrical Installations," by J. S. Cliff.

HAMMERSMITH.—Windsor Castle Hotel, 134, King Street, 7.30 p.m. A.S.E.E. West London Branch. "Types of Meters and Metering with Special Reference to the Trivector," by E. H. McCarthy.

LEEDS.—1, Whitehall Road, 6.30 p.m. I.E.E. North Midland Students' Section. "The Design of 66 kV and 33 kV Distribution Substations," by E. Bratton.

LONDON.—Savoy Place, 5.30 p.m. I.E.E. Measurements Section. "Determination of the Static and Dynamic Elastic Properties of Resilient Materials," by R. S. Jackson, Dr. A. J. King and C. R. Maguire. "A Method of Using Microwaves for Measuring Small Displacements and a Torque Meter using this Principle," by N. C. de V. Enslin (to be read by Prof. R. Guelke). "Magnetic Measurement of Mechanical Hardness," by D. Hadfield.

1, Birdcage Walk, 6.30 p.m. Institution of Mechanical Engineers, Graduate Section. "Electric Railway Stock," by B. T. Scoles.

At the Royal Society of Arts, John Adam Street, 7 p.m. Incorporated Plant Engineers, London Branch. "Fans and Fan Engineering Equipment," by C. J. Atkins.

OLD PORTSMOUTH.—At the B.E.A., High Street, 7.30 p.m. A.S.E.E. Portsmouth Branch. Lecture.

RUGBY.—College of Technology and Arts, 6.30 p.m. I.E.E. Rugby Students' Section. "Machines, Animals and Information," by B. Z. de Ferranti. Annual general meeting.

SHEFFIELD.—Grand Hotel, 7.30 p.m. Institution of Works Managers, Sheffield Branch. "Production Planning and Control—American Methods," by T. Greenlees.

Tuesday, 6th April, to Thursday, 8th April

LONDON.—Grosvenor House, W.1. Exhibition of Radio and Electronic Components, Valves and Test Gear.

Tuesday, 6th April, to Friday, 9th April

LONDON.—Caxton Hall and Connaught Rooms. E.D.A. Sales Conference.

Wednesday, 7th April

BIRMINGHAM.—James Watt Memorial Hall, Great Charles Street, 7 p.m. Junior Institution of Engineers, Midland Section. "The Development of Steam Power," by W. K. V. Gale.

BRADFORD.—Midland Hotel, 7.30 p.m. A.S.E.E., Bradford Branch. "Photography and the Engineer," by R. Almond.

EDINBURGH.—12, Rothesay Place, 7 p.m. I.E.S. Edinburgh Centre. Annual general meeting and films.

GLASGOW.—At the Institution of Engineers and Shipbuilders, 7 p.m. I.E.E. South-West Scotland Sub-Centre. "A New Approach to the Theory and Operation of Electrostatic Precipitators for Use on Pulverized-Fuel-Fired Boilers," by Major N. Troost.

LONDON.—Savoy Place, 5.30 p.m. I.E.E. Radio and Measurements Sections. "A Versatile Transistor Circuit," by E. H. Cooke-Yarborough. "The Measurement of the Small-Signal Characteristics of Transistors," by E. H. Cooke-Yarborough, C. D. Florida and Dr. J. H. Stephen. "A Bridge for Measuring the a.c. Parameters of Type 'A' Transistors," by Dr. A. R. Boothroyd and L. K. Datta. "The Transistor as a Regenerative Amplifier with some Application to Computing Circuits," by G. B. B. Chaplin.

MANCHESTER.—N.W.E.B., Town Hall Extension, 6 p.m. I.E.S. Manchester Centre. "The Lighting of Industrial Open Spaces," by J. S. Smyth.

MIDDLESBROUGH.—Cleveland Scientific and Technical Institute, 6.30 p.m. I.E.E. Teesside Sub-Centre. Annual general meeting followed at 6.45 p.m. by "A Logical Approach to the Problems of Electric Space-Warming," by D. H. Parry.

NEWCASTLE-UPON-TYNE.—Roadway House, 8, Oxford Street, 6.15 p.m. I.E.S. Newcastle Centre. Annual general meeting.

PAISLEY.—At the canteen of Eadie Bros. & Co., Ltd., 7.30 p.m. Institution of Works Managers, Paisley Group. Annual general meeting.

PORTSMOUTH.—College of Technology Extension, Anglesea Road, 6.30 p.m. I.E.E. Southern Centre. Annual general meeting followed by film evening.

PRESTON.—49a, Fishergate, 8 p.m. A.S.E.E. Preston Branch. "H.r.c. Fusegear," by E. Jacks.

SOUTHAMPTON.—Polygon Hotel, 7.30 p.m. Incorporated Plant Engineers, Southampton Branch. "Feed Water Treatment."

TORQUAY.—Electrical Hall, 3 p.m. I.E.E. South-Western Sub-Centre. "The Royal Festival Hall: Electrical Installation," by J. G. Hunter.

TREFOREST.—Glamorgan Technical College, 6.30 p.m. British Institution of Radio Engineers, South Wales Section. "The Manufacture of Radio Receiving Valves," by G. P. Thwaites.

Thursday, 8th April

ARBORFIELD.—R.E.M.E. Training Centre, Hazebrouck Barracks, 6.30 p.m. I.E.E. London Students' Section district meeting. "Machines, Animals and Information," by B. Z. de Ferranti.

LIVERPOOL.—Electricity Showroom, Whitechapel, 7 p.m. E.P.E.A. Merseyside Technical Group. Discussion on "Power Station Operating Efficiency," opened by D. F. Grant.

LONDON.—Café Royal, 7 p.m. I.E.E. Supply Section. Dinner-dance.

At the Institution of Mechanical Engineers, Storey's Gate, 4.30 p.m. Institute of Fuel, London Section. Annual meeting followed at 5.30 p.m. by Presidential Address by Dr. W. Idris Jones.

Manson House, Portland Place, 7 p.m. Society of Instrument Technology. Discussion on "Rationalization of Units for Electrically Operated Servos."

SLOUGH.—Community Centre, Farnham Road, 7.30 p.m. Institute of Welding, Slough Section. Annual general meeting.

Thursday, 8th April, to Tuesday, 13th April

LONDON.—Imperial College. Scientific Instruments and Apparatus Exhibition (Physical Society).

Friday, 9th April

COVENTRY.—G.E.C. Social Club, 8 p.m. I.E.E. South Midland Students' Section. Supper dance.

CREWE.—Royal Hotel, 7.30 p.m. A.S.E.E. Stoke and Crewe Branch. "Power Factor Correction of Industrial Loads."

GLASGOW.—Royal Technical College, 7 p.m. Institute of Fuel, Scottish Section. Annual general meeting followed by "High-Temperature Heating Fluids," by C. M. Auty.

LONDON.—Townsend House, Greycoat Place, S.W.1, 7 p.m. Junior Institution of Engineers. "Modern Laundry Machinery," by A. J. Simpson.

NEWCASTLE-UPON-TYNE.—King's College, 6.30 p.m. I.E.E. North-Eastern Students' Section, Tyneside meeting. Annual general meeting.

WEYMOUTH.—Technical College, 6.30 p.m. I.E.E. Southern Centre. Discussion on "Electric Space Heating," opened by K. Orchard.

Friday, 9th April, to Sunday, 11th April

HORSHAM.—Roffey Park. Society of Industrial Engineers. Conference on Work Study and Planning Applied to Plant Maintenance.

National Foundry College

Contributions of machines, equipment and money to the value of £14,000 have been received from a number of manufacturers by the new National Foundry College at Wolverhampton, opened recently by Sir Gilbert Flemming, Permanent Secretary to the Ministry of Education. Among the contributions is a Downsand magnetic moulding machine made and presented by British Insulated Callender's Cables, Ltd. This type of machine is specially designed for the production of moulds for flat or shallow castings and is capable of a high output—up to as many as 75 complete moulds an hour.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (2s 8d each including postage) will be obtainable after 12th May from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1950

10744. Electric & Musical Industries, Ltd. —Electrically conducting cements. 27th April, 1951. (708904.)

13991. Fechheimer, C. J.—Dynamo-electric machines. 5th June, 1950. (708905.)

31015. Westinghouse Brake & Signal Co., Ltd., and Walker, A. H. B.—Apparatus for the supply of d.c. to a load circuit from an a.c. source through a rectifier. 25th September, 1951. (708721.)

1951

2665. General Electric Co., Ltd., and Williams, C. E.—Decorative lighting arrangements incorporating electric-discharge lamps. 13th December, 1951. (708918.)

5408. British Thomson-Houston Co., Ltd. —Apparatus for controlling the angular rotation of electric motors. 10th April, 1952. (708723.)

6193. Aladdin Radio Patents, Ltd., and Garrett, H. A.—Coil formers for electrical inductances. 6th March, 1952. (708922.)

6546. Gillott, W. A., and Barton, A. V.— Electric heating devices. 10th January, 1952. (708923.)

7938. Sunvic Controls, Ltd., and Hall, C. C.—Electrical control arrangements. 27th March, 1952. (708726.)

8711. Marconi's Wireless Telegraph Co., Ltd.—Television and other apparatus employing cathode-ray tubes. 30th November, 1951. (708727.)

9854. Ferranti, Ltd.—Electric fires. 22nd July, 1952. (708926.)

9993. Electric & Musical Industries, Ltd. —Electrodes which are capable of emitting photo-electrons or secondary electrons. 26th March, 1952. (708927.)

10351. British Optical & Precision Engineers, Ltd., and Minister of Supply.— Electrode construction of electroscopes. 15th July, 1952. (708728.)

10518. Murphy Radio, Ltd.—Radio receivers. 5th May, 1952. Cognate application 2844, 2nd February, 1952. (708730.)

11529. Imperial Chemical Industries, Ltd. —Electric switches, responsive to the stoppage of driven machines. 16th May, 1952. (708931.)

12233. EK, F.—Contact banks for crossbar switches. 24th May, 1951. (708933.)

14236. Reyrolle & Co., Ltd., A.—Electric circuit breakers. 28th May, 1952. (708941.)

14907. General Electric Co., Ltd., and Ledger, R.—Dynamo-electric machines. 16th June, 1952. (708734.)

14966. Parsons, Ltd., C. H., and Handley, G. B.—Lever-operated electric switches. 7th August, 1952. (708942.)

15394. Jacquier, P. A. C.—Positive electrodes for alkaline accumulators. 28th June, 1951. (708736.)

15448. Electric & Musical Industries, Ltd. —Circuit arrangements for reducing variations of amplitude of high-frequency oscillations. 12th June, 1952. (708737.)

16091. English Electric Co., Ltd.—Bearings for measuring instruments. 20th June, 1952. (708829.)

16336. English Electric Co., Ltd.—Electric stud welding. 27th June, 1952. (709067.)

17983. Cockman, P. W.—Actuation of controllers for electric motors. 7th July, 1952. (708949.)

18005. General Electric Co., Ltd., and Foot, J. B. L.—High-frequency electrical oscillators. 17th July, 1952. (708833.)

18111. Metropolitan-Vickers Electrical Co., Ltd.—Radiation pyrometers. 30th July, 1952. (708950.)

18357. Thorn Electrical Industries, Ltd.— Circuits for electric-discharge tubes. 7th July, 1952. (708951.)

18859. Standard Telephones & Cables, Ltd.—Welding control arrangements. 8th August, 1952. (708747.)

21083. Pye, Ltd.—Television transmitting apparatus. 8th September, 1952. (708841.)

23275. Fitch, C. K.—Electric connectors. 6th October, 1952. (708959.)

25231. British Thomson-Houston Co., Ltd.—Control systems employing saturable reactors. 29th October, 1951. (708853.)

25551. Prawitz, C.—Control switch for controlling the pressure of a medium. 1st November, 1951. (708962.)

28306. Perkins, Ltd., F.—Control arrangements for connecting an electric generator to an existing electric main. 8th May, 1952. (708857.)

28639. British Thomson-Houston Co., Ltd.—Radio beacons. 6th December, 1951. (709029.)

1952

247. Philips Electrical Industries, Ltd.— Electric discharge having electrodes with flat surfaces. 3rd January, 1952. (708971.)

348. Standard Telephones & Cables, Ltd. —Telephone station ringing equipment. 4th January, 1952. (709081.)

1504. British Thomson-Houston Co., Ltd. —Hydraulic operating mechanisms. 14th January, 1953. (708863.)

3432. Nagard, Ltd.—Electronic amplifiers. 8th May, 1953. (709036.)

4224. Standard Telephones & Cables, Ltd.—Engine indicators. 6th February, 1953. (708765.)

4650. Bulgin & Co., Ltd., A. F.—Electric lampholders. 23rd February, 1953. (708978.)

5074. Rheinpreussen Akt.-Ges. Fuer Bergbau und Chemie.—Electrically operated conveyor means. 26th February, 1952. (708872.)

5488. Sola Electric Co.—Transformer arrangements. 3rd March, 1952. (708980.)

5701. Accumulatoren-Fabrik Akt.-Ges.— Process for the production of vulcanized microporous separators of raw rubber. 4th March, 1952. (708874.)

6063. Frederiksen, H. E.—Switches for overhead monorail systems. 7th March, 1952. (709084.)

6555. Hazeltine Corporation.—Automatic-gain control apparatus for television receivers. 13th March, 1952. (709038.)

7540. Edison Swan Electric Co., Ltd.— Saw-tooth amplifier circuits. 24th March, 1952. (708983.)

7685. Decca Record Co., Ltd.—Sound recording apparatus. 4th February, 1953. (708773.)

8376. Westinghouse Air Brake Co.— Electrical relays. 2nd April, 1952. (708985.)

9820. Mechanical Products, Inc.—Automatic electric circuit breakers. 18th April, 1952. (709086.)

11420. British Thomson-Houston Co., Ltd.—Magnetic cores. 6th May, 1952. (708,995.)

13276. British Thomson-Houston Co., Ltd.—Dynamo-electric machines. 26th May, 1952. (708784.)

13859. Telefonaktiebolaget L. M. Ericsson. —Electrical contact means. 30th May, 1952. (708885.)

14124. Gard, C.—Aerodrome lighting fittings. 4th June, 1952. (709043.)

15248. Telefonaktiebolaget L. M. Ericsson. —Cross-bar switches having bars crossing each other. 17th June, 1952. (708887.)

15902. Hoover, Ltd.—Suction cleaners. 24th June, 1952. (709090.)

17094. Lufttechnische Ges.—Circuit arrangements for measuring electric charges applied to a condenser. 7th July, 1952. (708891.)

17095. Lufttechnische Ges.—Circuit arrangements for the measurement of very small electric conducting values. 7th July, 1952. (708892.)

18248. Edison Swan Electric Co., Ltd.— Ceiling roses, lampholders, switches, and other electrical devices of the surface-mounting type. 18th July, 1952. (708790.)

19215. Arlux.—Explosion-proof electrical plug-and-socket connecting device. 30th July, 1952. (709047.)

19538. General Electric Co.—Electrically heated blankets and the like. 1st August, 1952. (709048.)

22982. Babcock & Wilcox, Ltd.—Furnaces. 12th September, 1952. (709094.)

23835. Philips Electrical Industries, Ltd. —High-frequency heating generators. 23rd September, 1952. (708796.)

25722. Standard Telephones & Cables, Ltd.—Electric rectifying devices employing semi-conductors. 14th October, 1952. (708899.)

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 17th April:—

ANIMOTORS. No. 726,080, Class 7. Battery driven electric motors for use in the animation of cardboard and the like window displays.— Leon Goodman Displays, Ltd., 119–125, Whitfield Street, Tottenham Court Road, London, W.1.

CONSTAVOLT. No. 719,890, Class 9. Voltage and current stabilizers, rectifiers, transformers, battery eliminators, battery chargers and field and armature controllers, all being electrical apparatus.—Winston Electronics, Ltd., 1, Park Road, Hampton Hill, Hampton, Middx.

VIDEOPHONE. No. B723,680, Class 9. Television apparatus.—Pye, Ltd., Radio Works, St. Andrews Road, Cambridge.

ERODOSHARP. No. B724,590, Class 9. Electrical apparatus for use in the working of metals.—Wickman, Ltd., Banner Lane, Tile Hill, Coventry.

OSRAM. No. 726,281, Class 11. Lighting appliances and installations.—General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

CERESCOPE. No. 726,186, Class 11. Carbons for electrical purposes.—Charles H. Champion & Co., Ltd., National House, 60–66, Wardour Street, London, W.1.

FLUOLION. No. 725,672, Class 17. Packings and jointings (in the nature of packings), insulators (electric) and insulating materials.— James Walker & Co., Ltd., "Lion" Works, Woking, Surrey.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia. — SYDNEY. 10th May. Electricity Commission of New South Wales. 132 kV power line carrier protective relay equipment for 50 c/s transmission lines. (E.S.B. 7369/54. Ten/8701.)*

Belfast.—9th April. Antrim Education Committee. Electric heating and lighting installation at Whitewell primary school. D. Whatmore Bell, architect, 41-51, Royal Avenue.

7th May. Electricity Department. Fire fighting equipment for substations. (See this issue.)

Birmingham.—23rd April. City Council. Six electric lifts and electrical installations in blocks of flats. (See this issue.)

Durham.—12th April. County Council. Electrical installation at Cambridge House Hostel, Barnard Castle. County architect, Court Lane, Durham.

Egypt. — CAIRO. — 15th April. Cairo Electricity and Gas Administration. 20 kW of underground h.v. cable. (E.S.B. 7696/54. Ten/8730.)*

Ellesmere Port. — 19th April. U.D.C. Street lighting equipment. (See this issue.)

Heckmondwike.—27th April. U.D.C. Electrical work in houses, Dale Lane. Estate Surveyor, Council offices, 6, Church Street.

India.—MADRAS.—24th April. Government Department of Electricity. Substation structures, outdoor and indoor switchgear and power transformers for the remodelling of the Madras distribution system. (E.S.B. 7164/54. Ten/8714.)*

NEW DELHI.—14th April. Directorate General of Supplies and Disposals. Horizontal type automatic electrically heated hardening furnace. (E.S.B. 7633/54. Ten/8727.)* 15th April. Electric heat treatment furnace. (E.S.B. 7599/54. Ten/8732.)* 19th April. Cable and cable boxes. (E.S.B. 7560/54. Ten/8722.)*

Kuwait.—16th May. Government of Kuwait. 415 V distribution fusegear. (See this issue.)

London. — STEPNEY. — 17th May. Electrical installations in flats, Sidney Street. (See this issue.)

Manchester.—10th April. Transport Committee. Trolley wire. (See this issue.)

Pakistan. — KARACHI. — 19th April. Post & Telegraph Directorate. Telephone cable and accessories. (E.S.B. 7922/54. Ten/8761.)*

Philippine Republic. — MANILA. — 11th May. National Power Corporation. Switchgear, appurtenances, accessories and spares for Balintawak substation, Agno River Hydroelectric Project, Quezon City, Luzon. (E.S.B. 7414/54. Ten/8709.)*

South Africa. — PRETORIA. — 9th April. Transvaal Provincial Tender Board. Underground cable. (E.S.B. 7424/54. Ten/8707.)*

Electrical material including plug bases, circuit breakers, lamps, bells, switch fuses, lightning arrestors, etc. (E.S.B. 7409/54. Ten/8718.)*

United States.—DENVER.—15th April. Bureau of Reclamation. Air switches and disconnecting fuses. (E.S.B. 7831/54. Ten/8751.)* H.v. disconnecting switches and fuses. (E.S.B. 7846/54. Ten/8766.)*

Uruguay.—MONTEVIDEO.—29th June. Usinas Electricas y los Telefonos del Estado. Steam generating units. (E.S.B. 7735/54. Ten/8740.)*

3rd May. Ministerio de Salud Publica. Radio receivers. (E.S.B. 7791/54. Ten/8747.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Bournemouth. — Corporation Transport Committee. Recommended. Electrical equipment for power supply for Corporation trolley-buses (£41,135 plus £7,199 for cables).—Hackbridge & Hewittic Electric Co.

Bromley. — Corporation. Recommended. Electrical installation in St. George's C.E. (Controlled) Primary School, Bickley (£1,030).—Reid & Barrow.

Lancashire. — Education Committee. Re-wiring work at Ashton-under-Lyne, West End County Infants', West End Boys' County Secondary, and West End Girls' County Secondary Schools (£2,752). —H. Bailey & Co.

London.—L.C.C. Electrical installation at Annandale Primary School, Greenwich (£1,514).—Electrical Contracting Co.

Middlesex. — Education Committee. Renewal of electric lighting and wiring at Ealing County School for Boys (£1,743).—Electrical Contracting Co.

Peterborough. — Corporation Highways Committee. Recommended. Electrical installations in staff cottages and compressor house of the Peterborough sewerage purification scheme (£2,173).—Peterborough & District Electrical Services.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Acton.—Apprentice training school at Kendal Avenue; Metal Box Co., Ltd., The Langham, Portland Place, W.1.

Multi-storey flats, South Acton; borough engineer, Town Hall, W.3.

Banstead. — Licensed premises at Cromwell Road Corner, Cuddington; Goodhews, Ltd., licensed caterers, 85, Buckingham Gate, S.W.1.

Barking.—Six shops and 22 flats, Ripple Road; borough architect.

Barrow. — Licensed premises for Catterrall & Swarbricks, Ltd., Blackpool; Fairbrother, Hall & Hedges, architects, 2, Birley Street, Blackpool.

Bath.—Rural science block, City of Bath Training College, Newton Park; Gerrard, Taylor & Partners, architects, 4/5, Bridge Street, Bath.

Battle (Sussex).—Houses and flats (30), Bishops Lane, Robertsbridge; A. H. Neave, architect to R.D.C., 38, Mount Street.

Belper.—Houses (70), Kilburn, for R.D.C.; J. H. Fryer, Ltd., Derby.

Birmingham.—Church hall, Kingsbury Road, Pype Hayes; Homer & Lynch, architects, 3/5, Church Street, Brierley Hill.

Bristol.—Block of shops and showrooms and offices, Union Street; city architect.

Chesterfield.—Block of 36 flats on Pevensey estate; borough architect.

Corby.—Dwellings (672), five shops, etc., to be built by Corby Development Corporation on Hazey Leys estate in next three years; Corporation's architects, Corby, Northants.

Coventry.—Ten shops with maisonnettes over at Bell Green neighbourhood unit; C. F. Redgrave & Partners, architects, 6, The Quadrant, Warwick Road, Coventry.

Darlaston.—Flats (44), Bentley estate; G. R. Rowlands, clerk to U.D.C., Town Hall.

Enfield.—Works extensions; Middleton Tool & Engineering Co., Ltd., Alexandra Road.

Exeter.—Development of site in Fore Street; Town Tailors, Ltd., Mabgate, Leeds, 9.

Harrogate. — Factory, Hookstone, Avenue; Robert Hirst & Co., Ltd., raincoat manufacturers, Hammerton Street, Bradford.

Haywards Heath.—Erection of 60-bed hospital on site near Hurstwood Park Hospital (£98,000); South East Metropolitan Regional Hospital Board, 11, Portland Place, London, W.1.

Huyton-with-Roby.—Houses (104), St. John's Road; U.D.C. surveyor.

Kew (Surrey).—Identification block at Commonwealth Mycological Institute; Waterhouse & Ripley, architects, Staple Inn Buildings, High Holborn, W.C.1.

Kineton.—Fire station for Warwickshire C.C.; R. Brisker & Sons, Ltd., Ashleigh House, Lighthouse Road, Kineton.

Kirkby (Liverpool).—Development of site in South Boundary Road; Waygood-Otis, Ltd., lift manufacturers, Falmouth Road, London, S.E.1.

Liverpool.—Offices, warehouse and showrooms in Greek Street; J. Davies &

Co. (Liverpool), Ltd., wholesale clothiers, 11, Russell Street, 3.

London. — KENSINGTON. — Primary school; W. J. Marston & Son, Ltd., builders, 1, Stephendale Road, S.W.6.

SOUTHWARK.—Dwellings (336), Alberta Street area; borough engineer.

Loughborough. — Houses (26), on Ashby Road estate; Wm. Corah & Son, Ltd., Pinfold Gate Works, Loughborough, Leics.

Lowestoft.—Factory for Bally's Shoes, Ltd., Norwich; R. G. Carter, Ltd., builders, Drayton, Norwich.

Maidenhead.—Houses (30), Larchfield/Curls Lane estate; C. T. Read, borough surveyor, 14, Craufurd Rise.

Middleton.—Factory in Green Street East; Townley Knitting Co., Ltd., Townley Street.

Morecambe.—Congregational church and school at Broadway and Stuart Avenue; A. D. Thomas, Wheatfield Street, Lancaster.

New Addington.—Factory, Vulcan Way; E. F. Langdale, Ltd., 24, St. Cross Street, E.C.1.

Northampton.—Science block at the Grammar School (£41,600); county architect, County Offices, Guildhall Road, Northampton.

Norwich.—Factory, Harford estate; Fletcher & Son, Ltd., printers, Castle Works.

Nottingham. — Erection of Deering Secondary Modern Mixed School; Progressive Builders, Ltd., Lowater Street, Carlton.

Oldbury.—Houses (184), Titford estate; Morris & Jacombs, Ltd., 71, Hobmoor Road, Birmingham.

Houses (89), on the Brandhall estate; borough engineer, Municipal Bank Chambers, Birmingham Street.

Plymouth.—Flats and maisonnettes (54), Ker Street and Stoke Road; city architect.

Poulton-le-Fylde.—Hotel, Longhouse Lane (£21,500); Fairbrother, Hall & Hedges, architects, Barclays Bank Chambers, Blackpool.

Rothwell.—Flats (40), Wood Lane site, for U.D.C.; F. Clough, Twickenham House, West Ardsley, Morley, Wakefield.

Salford.—Extensions to works at Ordsall Lane; Greengate & Irwell Rubber Co., Ltd.

Sheffield.—New premises at The Moor for Redmans, Ltd., Oldham Road, Newton Heath, Manchester; Shepherd, Fowler & Marshall, architects, 115, St. James Road, Sheffield.

Stockport.—Factory and offices in Craig Road; J. E. Cardwell & Co., Ltd., frock manufacturers, Waterloo Road.

Surbiton.—Ten shops, with dwellings over, Hook Road corner; Union Holdings, Ltd., 194, Walton Street, Kensington, S.W.3.

Tottenham.—Works extensions; Maynards, Ltd., Vale Road.

Watford.—Additions to Shrodells Hospital (£25,000); North West Metropolitan Regional Hospital Board, 11, Portland Place, London, W.1.

West Bromwich.—Extensions at Oldbury Road for Adams & Benson, Ltd.; Webb & Gray, architects, Tixdall House, St. James Road, Dudley.

Opportunities in Angola

ALTHOUGH the market in Portuguese West Africa (Angola) is, in practice, reserved for the products of Portugal, nevertheless there is a good demand for a variety of goods where these do not conflict with Portuguese or local manufacture. In his report on the economic and commercial conditions in Portuguese West Africa (H.M. Stationery Office, 2s 6d net), Mr. T. C. Sharman, H.M. Consul, British Consulate, Luanda, says that United Kingdom manufactures for which there is a good demand include machinery of all kinds, electrical fittings and accessories, refrigerators, generators, motors and transformers, and stationary power plant.

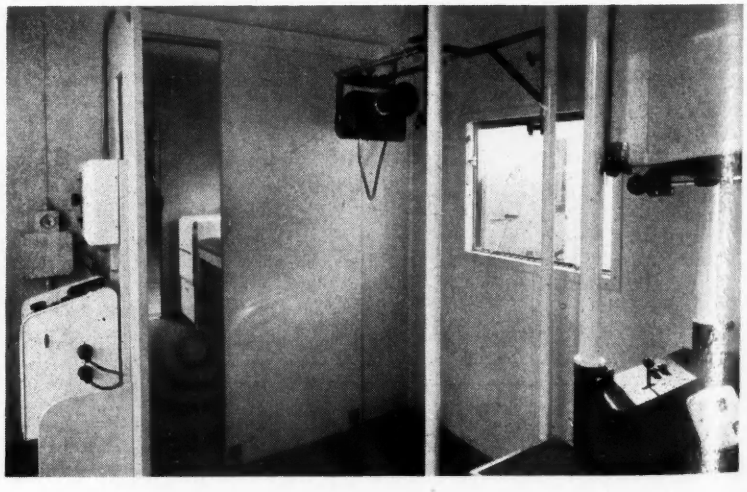
There is an evident need of capital goods which should in future years provide a valuable market for British manufacturers. It was anticipated that the bottle neck of electric power production would be broken in the Northern region around Luanda last year which would enable manufacturers and others to install electrical machinery.

Work is in hand to develop the hydro-electric resources of the country, and the Development Plan, 1953–58, provides for the extension of the Mobubas Project, completion of the Biopio Project and the execution of the Matala Project. Details of these schemes are given in Mr. Sharman's report, which also includes appendices showing the volume and classes of imports.

Mobile X-ray Clinic

A COMPLETELY self-contained mobile X-ray clinic has recently been built for a West African Government Health Department by Philips Electrical, Ltd., London. Destined for the Gold Coast, it will be used for mass chest survey of the native population in the Department's anti-tuberculosis campaign. As the clinic will have to cover long distances over wide areas, it is so designed as to be quite independent of the facilities normally available to hospitals and specialist clinics in large towns. The company claims that it has overcome the greatest problem—that of apparatus weight—by the employment of a photo-fluorographic X-ray unit. This is based upon the use of a spherical mirror camera which, being very much faster than a lens camera, enables a lower powered X-ray generator to be employed. The space required for such a unit is relatively small and it has therefore been possible to install all the principal equipment to be found in non-mobile clinics. A fully equipped darkroom, a standard domestic size refrigerator, examination couch, water storage tank, and other diagnostic and therapeutic aids, are all fitted with compactness, enabling speedy and thorough examinations to be made.

The power for the X-ray apparatus, fluorescent lighting, air circulators, film viewing lanterns, desiccator drying oven and other auxiliary equipment, is provided by a specially developed petrol electric generator unit.

The chassis is a 5-ton Bedford model. The walls are double skinned and insulated with fibre glass. The roof is triple skinned and, in addition to being fibre glass insulated, is also air ventilated. Awnings, to give shelter from the sun, are fitted and these, with the petrol electric generator, are stored in special compartments within the van.

Philips mobile X-ray clinic showing the operating room equipped with DX-L X-ray unit, and DX-L tube head mounted on photo-fluorographic stand